THE WESTERN NATURALIST

Volume Seven December 1978

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A Journal of Scottish Natural History

THE WESTERN NATURALIST

A Journal of Scottish Natural History

Editorial Committee:

Dr. J.A. Gibson

Dr. John Hamilton

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NOTES ON THE BREEDING OF THE BUZZARD IN KINTYRE

By EDWARD J. MAGUIRE
Kintyre Antiquarian and Natural History Society

Introduction

The information presented in this preliminary paper was obtained during 1977-78 by three observers (R.A. Angus, E.J. Maguire, and R.P. Morton) working over some 115 square miles of the Kintyre peninsula. The study was originally started to establish the breeding success of the Buzzard *Buteo buteo* in Kintyre, but now that so many breeding pairs have been located it is obvious that further studies should be undertaken.

In their paper on the breeding birds of Kintyre, Colville and Gibson (1958) pointed out that the Buzzard in Kintyre has had a very chequered career:

> "Formerly very common, but virtually extinct in Kintyre from middle to end of last century; increased again during the years of the first world war but more or less exterminated soon afterwards when the gamekeepers returned (*The Field*, 5th March 1925). Increased again during the last war and now fairly common and widely distributed".

From then on the Buzzard steadily increased in numbers and later, in the *Atlas of Kintyre Vertebrates* (1975), these same authors were able to record the present-day breeding distribution of the Buzzard from all except three of the nineteen 10 km. squares which comprise Kintyre.

There is no doubt that the Buzzard has steadily continued to increase within recent years, and is now certainly the most numerous large raptor in Kintyre. During 1978, at least 55 pairs were known to have bred, nearly 90 occupied territories were located, and it is virtually certain that the true figure exceeds 100.

Distribution and Density 1978

The Kintyre peninsula measures some 40 miles long from north to south, has an average breadth of seven miles, and covers an area of some 300 square miles. Although traversed by a range of hills, the heights of these nowhere exceed 1500 feet. At the north the peninsula is attached to the Argyll mainland of Knapdale by the narrow, mile-long isthmus at Tarbert.

The distribution of Buzzard territories north of Loch Lussa (710300) was found to be almost entirely peripheral. Here the spine of the peninsula is mainly open moorland and is thus unsuited to the Buzzard's nesting requirements. South of Loch Lussa and Campbeltown the Kintyre peninsula is much more uniformly wooded and here Buzzard distribution was much more even. In general, the densest concentrations are where the habitat is diverse, as one would expect. Our survey did not include the direct coastal strip of the Mull itself, approximately from Earadale Point (597173) to Bargadelmore Point (635060), nor the peripheral area north of Whitestone (790340) in east Kintyre, and in total covered an area of some 115 square miles.

In Kintyre, all territories were spaced regularly and nests were almost exclusively situated in small wooded glens adjacent to farmland, where a greater variety of both nest sites and prey habitat was apparent. During 1978, 88 occupied territories were located in an area of 115 square miles (chiefly marginal lands), giving an average population density of one pair per 1.31 square miles. Of these 88 pairs, 55 were known to have bred and six were non-breeding. The status of the remaining 27 pairs was not established.

Tubbs' (1974) method of calculating the territory size in the New Forest, by assuming each one to be a circle with a radius of half the average distance between nests, was used in Kintyre. Areas with a good breeding density were selected, and an estimate of territory size was obtained from three widely separated localities.

Table 1: Population densities and estimated territory sizes of Buzzards in Kintyre, 1978

	South	East	West	
Area surveyed (sq.mls)	38	21	56	115 total
Occupied territories	31	16	41	88 total
Area available per pair (sq.mls)	1.23	1.31	1.37	1.31 mean
Estimated territory size (sq.mls)	0.90	0.84	0.82	0.85 mean

Nest Sites

Sixty of the 89 nests known in Kintyre during 1977-78 were in trees. The majority of these were found in hardwoods, and heights above ground varied from 10-55 feet, averaging about 23 feet.

In Speyside, of 102 lines nests, 62% were in Scots Pine *Pinus sylvestris*, which was the commonest tree in the study area, although half the territories contained suitable hardwood alternatives (Picozzi and Weir, 1974). In 17 of 35 territories occupied for five or more years in the New Forest, nests were exclusively in Scots Pine (Tubbs, 1974).

In Kintyre, only 15 nests were in Scots Pine, but it was noted that mature trees of this kind were relatively scarce, or indeed absent, in many of the 55 territories where breeding was confirmed.

Table 2: Situations of Buzzard nests in Kintyre 1977-78

	1977	1978	Totals	%ge of Total
Hardwood Tree*	18	27	45	50.6
Scots Pine*	6	9	15	16.9
Bank by Stream	5	8	13	14.6
Crag*	3	8	11	12.4
Sea Cliff	2	3	5	5.6
Totals	34	55	89	100

* In each of these groups, one 1977 nest was re-used in 1978

Egg Laying

During 1978 the commencement of egg laying by Buzzards in Kintyre was calculated at 47 nests. This was done either by using the known hatching date (minority), or by ageing the oldest nestling. These approximations showed a spread of nearly forty days, from 27th March to 5th May, with a very definite peak between 16th and 25th April (Figure 1). This peak corresponds closely to the dates given by Bruce Campbell (1947) for Argyll, Picozzi and Weir (1974) for Speyside, and Tubbs (1974) for the New Forest. Brown (1976) also noted a remarkable consistency in the main laying period, from about 10th to 25th April, all over Britain.

The Kintyre approximations were made assuming a 36 day incubation period, although the precise length is still apparently uncertain. The Rev. F.C.R. Jourdain, in the *Handbook* (Witherby *et al*, 1939), says that incubation usually commences with the first egg, and gives 28-30 days as the incubation period. This statement is repeated by Bannerman (1956). More recently Brown (1976) says that recorded incubation periods in Britain vary from 36 to 38 days for each egg. In the only instance

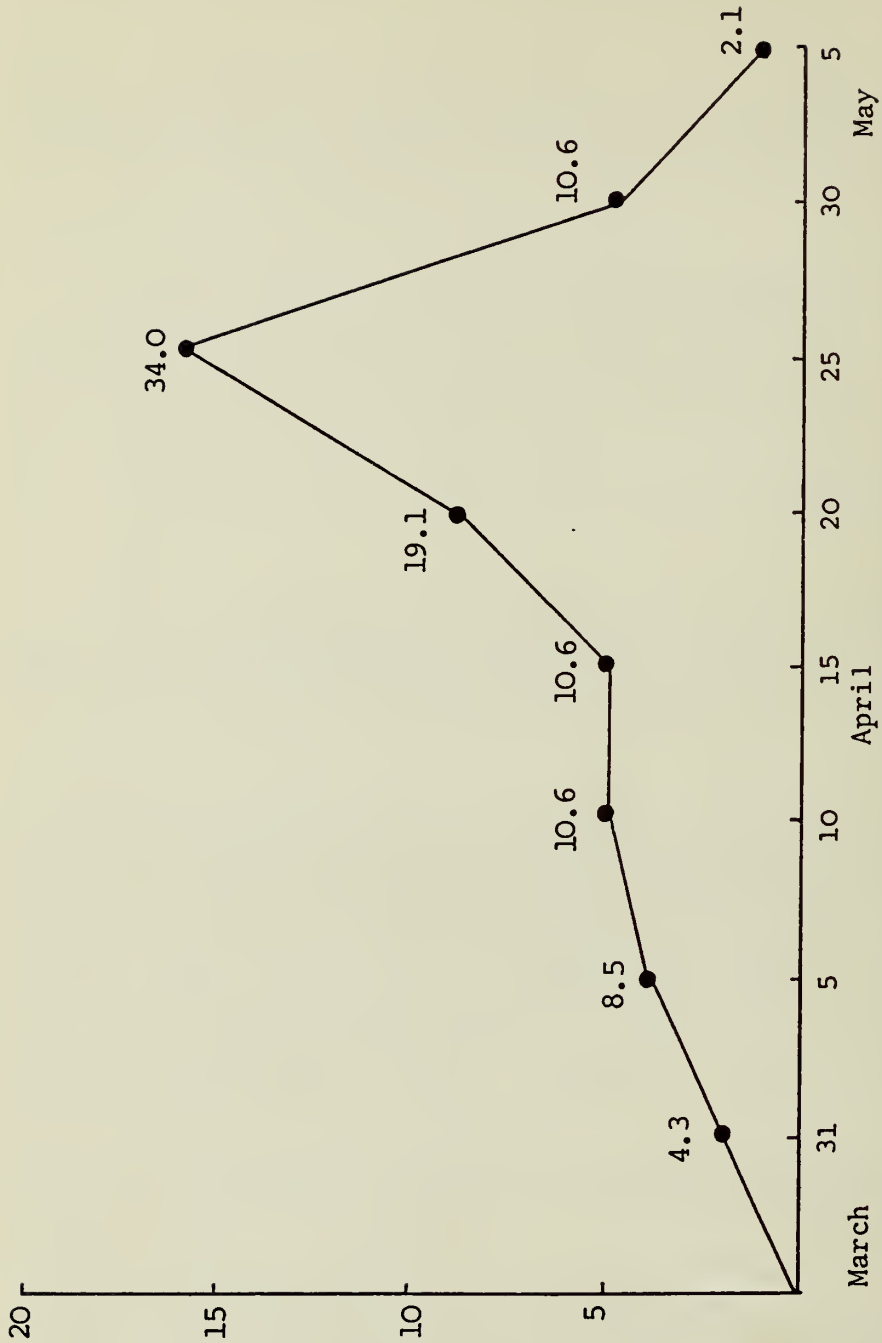

Figure 1: Commencement of egg laying at 47 nests of Buzzards in Kintyre during 1978. Above each point, at five day intervals, is shown the relevant percentage of nests.

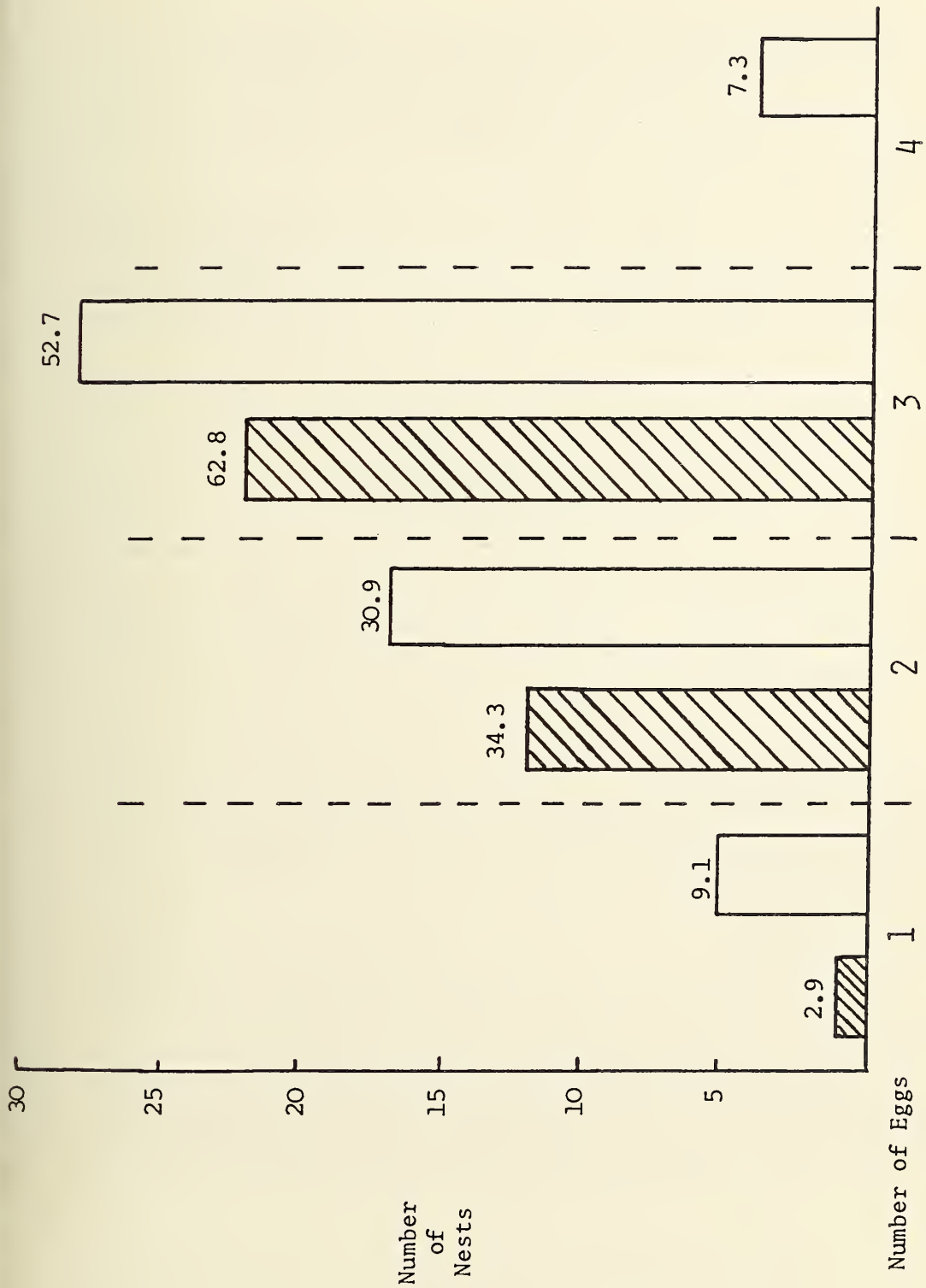

Figure 2: Clutch sizes recorded at 89 nests of Buzzards in Kintyre during 1977 ▨ and 1978 □. Percentage of nests containing given clutch size is indicated above each bar of the histogram.

during ten years in the New Forest when the exact laying and hatching dates were known, the first egg of a clutch of two hatched in 36 days (Tubbs, 1974).

Clutch Size

In Britain, Buzzards are recorded as normally laying two to three, occasionally one or four, and exceptionally up to six eggs. In Kintyre in 1977-78, 89 nests were examined during the incubation period (Figure 2). Of these 50 (57%) had clutches of three, 29 (33%) had two, 6 (6%) had one, and 4 (5%) had four. This gives a mean clutch size of 2.58.

Clutches of one were assumed to be completed, since there was no evidence to suspect otherwise. In Speyside, the loss of a single egg from a clutch was noted four times and in each case the cause was unknown (Picozzi and Weir, 1974). In Kintyre, no evidence was found of single egg losses. All egg losses known were of entire clutches.

Table 3: Summary of mean clutch size recorded for Buzzards in Kintyre 1977-78.

Data	1977	1978	Totals
Number of nests	34	55	89
Total eggs	88	142	230
Mean clutch size	2.59	2.58	2.58

Analysis of 641 Buzzard nest record cards from 1948 to 1969 by Tubbs (1972) revealed that British clutch sizes were largest in the Scottish Highlands, with an overall mean of 2.7 eggs per clutch. Brown (1976) noted that this figure was affected by the predominance of Speyside results, where the overall mean was 2.9 eggs per clutch between 1964-71.

Breeding Failures

Analysis of Buzzard nest record cards showed that failure to rear young once eggs had been laid was often due to egg loss, amounting to at least a third of all cases (Tubbs, 1972).

In Speyside, destruction and disturbance of Buzzards by man is widespread and was the chief cause of breeding failure (Picozzi and Weir, 1974). Tubbs (1974) found that clutch loss in the New Forest varied from 6.3 - 25%, mainly due to predation by crows.

In Kintyre, all total breeding failures occurred during the incubation period, and out of 89 nests eleven complete clutches, involving a total of 26 eggs, were lost.

It is known that at least two of these clutches were taken by humans.

Table 4: Causes of total breeding failure of Buzzards in Kintyre 1977-78.

Causes	1977	1978	Totals
Human predation	2	-	2
Clutch addled	1	2	3
Avian predation (?)	1	1	2
Unknown	2	2	4
Total failures	6	5	11
Total nests	34	55	89
Percentage	17.6	9.1	12.4

Addled Eggs

In addition to the above losses, single addled eggs in otherwise fertile clutches accounted for the loss of a further seven eggs. Total egg loss was thus 33/230 or 14%.

Brood Depletion

In the early stages of the fledgling period thirteen chicks disappeared from, or were found dead in, a total of twelve nests. Inter-sibling pugnacity was suspected in many of these cases. Brown (1976) noted that the elder chicks in a brood are very much heavier and more active than the younger, and are therefore more likely to get whatever food is available. These older chicks are also known to resist the attempts of younger nest-mates to obtain food. Losses among broods, therefore, are not always obviously related to food supply: losses have been known to occur at nests where an abundance of food was available (Tubbs, 1974). At one 1978 nest in Kintyre two out of a brood of three were found dead at the edge of the nest, where they remained untouched by the remaining occupant, and the adults, for at least five days (R.A.G. Angus, *pers. comm.*).

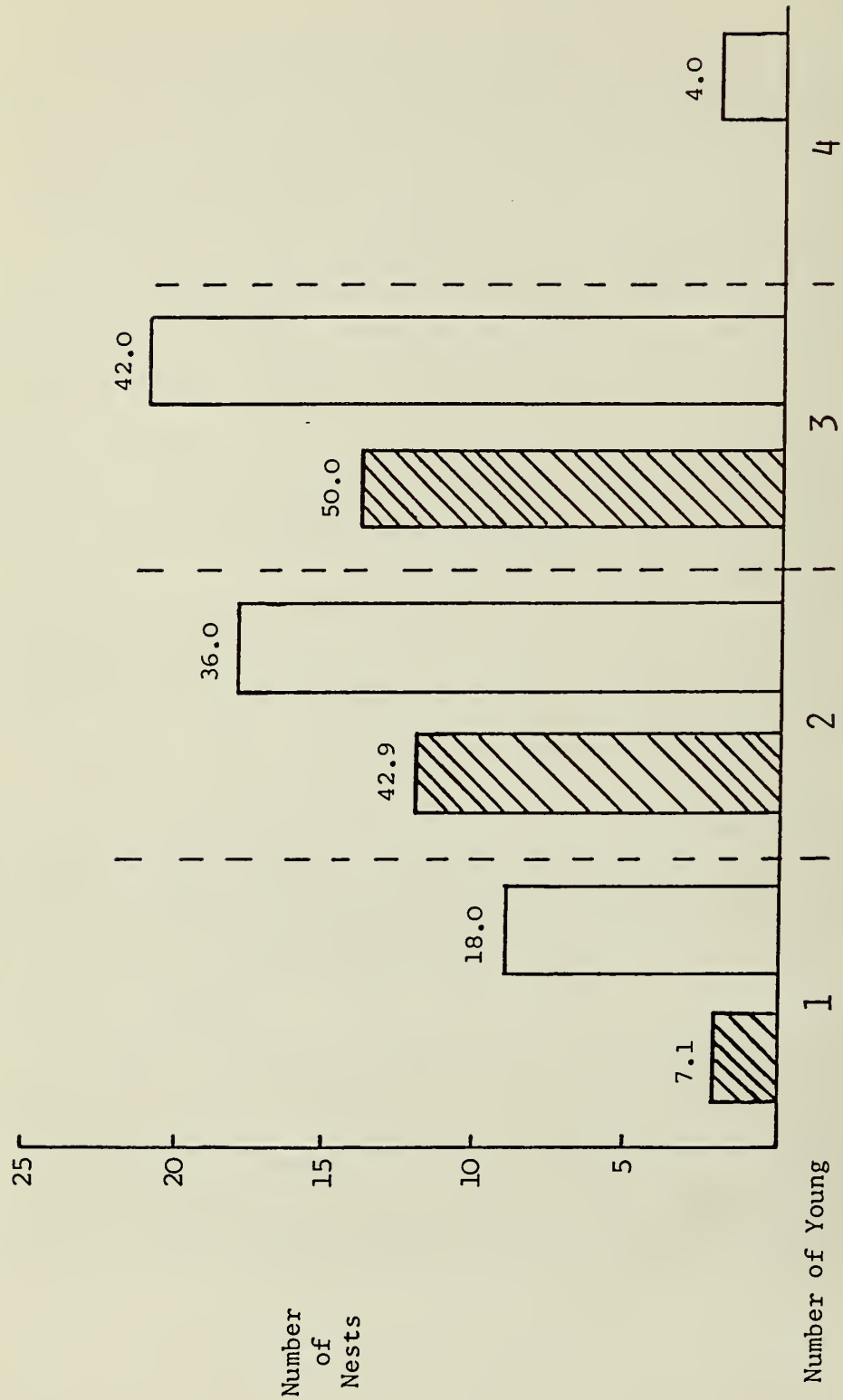

Figure 3: Brood sizes recorded at 78 successful nests of Buzzards in Kintyre during 1977 ▨ and 1978 □. Percentage of nests containing given brood size is indicated above each bar of the histogram.

Table 5: Brood depletion recorded from 12 nests of Buzzards in Kintyre 1977-78

Circumstances	1977	1978	Totals
Disappeared from nest	4	6	10
Found dead on nest	-	3	3
Total chick loss	4	9	13
Total eggs hatched	72	125	197
Percentage chick loss	5.6	7.2	6.6

Brood Size

The overall mean brood size of 78 successful nests in Kintyre was 2.36. The figure is greater than the mean given for any other area of Britain except Speyside, where the overall mean per successful nest was 2.56 from 1969-72 (Picozzi and Weir, 1974). Tubbs' (1972) analysis of the nest record cards revealed that the highest recorded mean number of young fledged per successful nest was 2.2 in the Scottish Highlands. The Kintyre data are comparable with both figures (see Figure 3).

Table 6: Summary of mean brood size recorded at 78 successful nests of Buzzards in Kintyre 1977-78.

Data	1977	1978	Totals
Number of nests	28	50	78
Total young fledged	68	116	184
Mean brood size	2.43	2.32	2.36

Prey Remains

In 1978, prey remains of 23 vertebrate species were identified at Buzzard nests in Kintyre. It was obvious that Rabbits were the most important item in terms of weight, being recorded in good numbers on all nests. Other small mammals were probably also important, but analysis of regurgitated pellets was rarely employed since this particular study was not an attempt to measure food. It is worth noting that no carrion (e.g. sheep, in particular) was found.

Table 7: Summary of prey recorded from 50 buzzard nests in Kintyre, 1978

Mammals:	
Hedgehog *Erinaceus europaeus*	Single; probable road casualty.
Mole *Talpa europaea*	Single in 2 nests
Pygmy Shrew *Sorex minutus*	Single
Common Shrew *Sorex araneus*	Single on 3 nests
Rabbit *Oryctolagus cuniculus*	Recorded on every nest
Wood Mouse *Apodemus sylvaticus*	Single
Short-tailed Vole *Microtus agrestis*	28 on 24 nests
Birds:	
Black Grouse *Lyrurus tetrix*	Single (male)
Pheasant *Phasianus colchicus*	3 chicks on 2 nests
Oystercatcher *Haematopus ostralegus*	Single (adult)
Herring Gull *Larus argentatus*	Single (adult)
Common Gull *Larus canus*	Single (immature)
Black-headed Gull *Larus ridibundus*	Single (adult)
Wood Pigeon *Columba palumbus*	8 on 6 nests
Hooded Crow *Corvus corone cornix*	6 on 5 nests
Rook *Corvus frugilegus*	3 on 3 nests
Jackdaw *Corvus monedula*	2 on 2 nests
Song Thrush *Turdus philomelos*	3 on 3 nests
Blackbird *Turdus merula*	Single (male)
Stirling *Sturnus vulgaris*	Single (juvenile)
Chaffinch *Fringilla coelebs.*	Single (adult female)
Reptiles:	
Adder *Vipera berus*	Single
Amphibians:	
Frog *Rana temporaria*	Single

Ringing:

During 1977 and 1978, 169 (62 and 107 respectively) nestling Buzzards were ringed in Kintyre. Of 107 1978 nestlings, 75% were also marked with coloured rings. This work is continuing and will be reported in due course.

Summary

During 1977 and 1978 a survey of breeding Buzzards was carried out in three selected areas, totalling 115 square miles, of Kintyre, Argyll. The survey methods were similar to those used by Tubbs (1974) in the New Forest and Picozzi and Weir (1974) in Speyside.

The density of the 88 known pairs in 1978 was one pair per 1.31 square miles, with an estimated mean territory size of 0.85 sq. miles. Almost 70% of the nests were in trees. Egg laying showed a very definite peak between 16th and 25th April, and the mean clutch size was 2.6. Reasons for breeding failure, including egg and chick losses, are analysed. The mean fledged brood size was 2.4. A survey of prey remains showed that a wide range of mammalian and avian prey was taken, the main prey being Rabbits, which were recorded in good numbers at all nests.

The study also included colour ringing of nestlings. This will be continued, and reported at a later date.

Acknowledgements

The contribution of R.A.G. Angus and R.P. Morton, in providing considerable help with locating and recording at nests, is gratefully acknowledged.

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HISTORICAL NATURAL HISTORY NOTES ON SOME IRISH FISHES

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Grants, leases, charters and other Irish historical records afford us valuable information on the natural history of many species of fishes found in Ireland, and more particularly those of commercial importance. I have always felt that historical documents relating to Ireland have been greatly under-utilised in this regard. In the course of a short paper of this kind one cannot deal in detail with all the species of fishes referred to in the Irish historical records, and it is therefore proposed to limit discussion to a small number of species, namely Salmon, Trout, Char, Pike, Carp, Tench, Shad, Sturgeon, and Basking Shark, to indicate the range of material available.

SALMON *Salmo salar*

The Salmon is, and was in former times, an important species, and one can follow the ownership of the Salmon fisheries of many Irish rivers down the ages, as I have indicated elsewhere (1). In addition to the question of ownership one can also follow the methods of fishing used down the ages. These methods indicate that our predecessors had a clear knowledge of the natural history of the species.

The famous Battle of Clontarf, also known as the Battle of the Salmon Weir, was fought in 1014 around an ancient fishing weir in Dublin Bay (2) which owed its success to the fact that it caught Salmon moving around the estuary of the River Liffey under the influence of the tide. Similar weirs were extensively used elsewhere in Ireland from an early date (3).

Riverine Salmon weirs, common throughout Ireland in former times (4) trapped Salmon moving upstream.

Until the nineteenth century few Salmon were captured in the open sea. A notable exception was at Carrick-a-rede, a small rocky islet off the coast of County Antrim, where a net was used, at least as early as the year 1790, when the Rev. William Hamilton produced a valuable book on the north Antrim coast (5). Careful examination of the position of the net reveals that the fishermen were mainly intercepting fish moving westwards along the Antrim coast in the neighbourhood of Carrick-a-rede. Whilst the original net has now been superseded by a newer type of net, scientific tagging investigations (6) here in the 1950s revealed that

there is, in fact, a substantial movement of Salmon in season near this islet from the east to the west, thus confirming the wisdom of early fishermen in using the net in the fashion shown in Hamilton's illustration.

TROUT *Salmo trutta*

At one period numerous 'species' of trout were recognised by ichthyologists. The Rev. W. Houghton (7), for example, recognised no less than twelve such species, but today all forms of native Trout are accepted as belonging to one species only, namely *S. trutta*.

One of the types of Trout formerly given specific rank was the Gillaroo (from *giolla*, fellow and *ruadh*, red). The earlier references to this type of Trout are to be found in the *Philosophical Transactions* (8), in which a letter dated 23rd December 1773 from the Hon. Daines Barrington to the Rev. Dr. Horsley was published as follows:-

> "You will find upon the table a Gillaroo trout, as it is termed in Ireland, the peculiarity of which is that the stomach very much resembles the gizzard of a bird.....
>
> Since that I have endeavoured to procure a specimen, with the entrails adhering, and have at last succeeded, the stomach upon the table having been extracted by Mr. Hunter, F.R.S. in the presence of several.....
>
> If the specimen now shown to the Society was a single one it might be considered as an accident; but there can be no doubt of trout being constantly caught with this extraordinary stomach in some of the Irish lakes, though the greater part indeed do not differ from the common sorts.....
>
> There are no exterior marks by which the specimen on the table can be distinguished from the common trout.....
>
> The poke of the Gillaroo seems to perform the office of a gizzard, because several small snails were found within the present specimen and I conclude this species of food abounds in the lake which this variety of trout frequents".

Barrington goes on to say Gillaroos are common in Lough Corrib and Lough Derg (in the Shannon system).

Barrington also follows his letter with a memorandum by

Walsh who described the gizzard of the Gillaroo, and also the fish itself, as follows:

> "The large Gillaroo has gizzards bigger than a turkey gizzard; they have gravel and little shells in them. Never seen a roe which is here called a pea in the gillaroo nor milt. They seldom take a Gillaroo at the spawning season. They are quite different from other trout; their spots are larger and fewer".

In the same volume of the *Philosophical Transactions* John Hunter, the famous anatomist, gave a discourse on the stomach of the Gillaroo and asked the question "How far this difference in thickness of stomach is sufficient to make a distinct species, or barely a variety of the same, is only to be determined by experiment".

Thomas Pennant (9) in 1776 mentioned that the stomachs of the Gillaroo are uncommonly thick and muscular. He obviously regarded the Gillaroo as identical in species with the common Trout. The full story of the Gillaroo is set out in a paper I published in 1951 (10).

In a description of County Down, published in 1774, there are some interesting references to the trout of Loughbricklan and Lough Neagh. The Loughbricklan reference (11) states:

> "*Loughbricklan*, i.e. the *Lake of Speckled Trouts*, with which it formerly abounded, till the Spawn of Pikes, finding a Passage into the Lake, multiplied so exceedingly, that they have almost destroyed the whole Breed.
>
> We are also told that *Lough Neagh* is remarked for two sorts of *Trouts*, one called the *Dolochan*, which is said to be peculiar to it, being 14 to 18 Inches long, which last Size it never exceeds, and always spawns in the Rivers running into the Lough. The other kind is called the *Buddagh*, some of which have been taken that amounted to 30 Pounds weight, whereas it is a large *Salmon* that weighs 35 pounds. This *Buddagh* seems to be the same fish found in the Lake of *Geneva*" (12).

These two "types" of Trout are mature lake Trout running into the tributary streams of Lough Neagh.

CHAR *Salvelinus alpinus* (13)

Although not an important commercial species, there are references to Char in the literature and historical documents before 1800. These references relate to Lough Allua (in the Lee system), Lough Eske near Donegal town, and the Comeragh Loughs on the side of the Cummeragh Mountains in County Water-

ford.

In the Cromwellian *Civil Survey* of 1656 (14) the earliest reference to Char occurs in the description of the barony of Muskerry. The relevant extract is as follows:

> "There are many rivers of note in this Barrony ye chiefest of all which is the River Lee aforsd, Which Issueth out of ye Lough called Gugane B near the West end of the Barronye and Issues of the sd Lough but in a small brook or Spring till running by several great hills and Mountains it becomes a large deep and pleasant Lough about two Miles long and in some places about a quarter of a mile broad, stretching out into ye Bowels of ye sd. land in several Branches and Corners and no ways passable within ye Compass aforesd, some salmon fish and some kind of Trouts almost as large as salmons, besides small Trouts, Eels and Charr which are deemed & Excellent fish, pleasant to its teast, beautifull to ye Eye about ten Inches long, its skin of a sanquine colour & to be found in Novr not by angleing but by a Nett when ye go up the small Rivers and Brooks to spawn the aforsd Month".

Almost a hundred years later Charles Smith made a close study of the Char of the lake in question and his notes are worth quoting in full as follows:

> "A small mile west of *Inshegeelagh* the river *Lee* opens into a fine lake called *Lough Allua* 3 *English* miles and ½ mile broad stretching out into several bays, it is deep and not fordable from end to end. Salmon trouts almost as large as salmon, small river trout various kinds of eels abound in it, also the *Charr* or *Alpine* trout" (15).

As a footnote Smith continues:

> "Having the opportunity of seeing these fish when I was at *Macroomp* I took down the following description of them. The *Charr* is at length from the extremity of the nose to the tip of the tail 10¾ inches breadth from the back fin to that on the belly 2¼ inches where it is thickest. Its eye resembles that of the herring; the mouth from the tip of the muzzle to the joint of the jaw somewhat more than an inch, both jaws are furnished with a row of small teeth; the back fin is pretty large, placed almost near the center like the pilchard's. It has a fin to each gill, a pair of belly fins and one near the tail and a small one on the back near the tail. The under jaw, head and back are of

> dark mud colour; the belly is a bright red like vermilion, shaded off with yellow and white; there is a remarkable small line running from the middle of the tail to the angle of the eye on both sides; they differ little from the common trout, as to shape; they boil like a salmon as do several of the trout kind; they will not rise at a fly, being always taken with a bait or in a net. They are never found in running water, nor can they be transported alive to any distance".

This is a good description of the Char and its natural history.

Camden's *Britannia* also has a short note on these Char as follows:

> "*Inchigeela* a small village at the foot of a mountain, a mile from whence the river Lee opens into *Lough Allua,* a fine like in which the charr fish abounds" (16).

Incidentally Char in Lough Allua became extinct about the year 1830, probably due to the accidental introduction of the Pike into the Lee system.

Another important Char water is Lough Eske near Donegal town, for which Camden has some notes in his *Britannia* (17) as follows:

> "*Lough Esk* near *Townavilly* yields char in great abundance, a most delicate fish, generally about 9 inches long. The male or milting char has a red belly, but the flesh is generally white; the female or roeing char has a paler belly but the flesh is of a bright red, and the fish is commonly bigger; the third sort is called the gelt, and by corruption the gilt char, is without roe. They are not to be caught by bait, but feeding in deep water are only taken in nets".

Seward (1795) (18), under Esk Lough, repeats Camden's remarks.

Charles Smith in his book *The Ancient and Present State of the County and City of Waterford,* first published in 1746, refers to lakes in the Cummeragh Mountains as follows:

> "In these mountains are four considerable loughs two of which are called by the Irish Cummeloughs and the other two Stilloges the longest of which contains about five or six acres. In these loughs are several kinds of trout; and in the former, are a species of fish called charrs, about two feet long, the male grey and the female yellow bellied; when boiled the flesh of the charrs is red and curdy as a salmon, and eats more

> delicious than any trout. It is remarkable, that this kind of fish is often found in such lakes situated in mountain districts as we learn from Dr. Robinson's Nat. Hist. of Westmorland and Cumberland" (19).

Smith, of course, was wrong as to the colour of the two sexes, the male in mature livery being yellow bellied.

PIKE *Esox lucius*

There is no doubt that the Pike is an introduced fish in Ireland (20). Giraldus Cambrensis in his *Topography of Ireland* (21), written at the end of the twelfth century, mentions the absence of the Pike. Apparently Giraldus came to Ireland in 1183 and again in 1185-86, landing with Prince John on the second occasion at Waterford. He travelled to Dublin by what route we know not, but it is known he was in Meath and Kildare, and Professor O'Meara suggests he may have seen the Shannon near Athlone with Lough Ree, perhaps also Lough Derg. He also seems to have had some knowledge of Arklow and Wicklow. Be that as it may, Giraldus could not have failed to know of the existence of the Pike, if indeed it were present. Giraldus' statement finds some confirmation from another source. The late Thomas F. O'Rahilly stated there was no name for the Pike in Old Irish, very surprising if such a noticeable fish were present.

Roderic O'Flaherty (22) wrote an account of part of County Galway in 1682, and he states that "there was never a pike or bream as yet engendered in all this countrey nor in the adjacent parts of Mayo or Galway counteys". Iar Connaught is the western part of County Galway and there is no doubt that the Pike was absent in O'Flaherty's day, otherwise he must have been familiar with it. Even as late as the early part of last century the Pike was absent from a considerable part of this area.

In other parts of the country, however, as will be seen from what follows, the Pike had established itself before 1682. We know that the abbey of Monasteranenagh near Croom, Co. Limerick, at the dissolution had weirs for Eels and Pike on the River Camoge (23). According to the Civil Survey (24) (1654-6) this river and other tributaries of the Maigue contained Pike. The priory of Tristernagh, on the shores of Lough Iron, at the dissolution had the tithes of certain weirs on the River Inny, which were compounded at "200 eels (1d), 16s 4d and 2 pykes (16d), 2s 8d" (25). Sir Henry Piers (26), writing in the year 1682, stated that Pike were present in Lough Iron, the River Gaine, and Lough Bannen-Annagh in the north of Westmeath. Thomas Dineley, who visited Ireland in the reign of Charles II, speaks of Pike in the Rivers Barrow, Nore and Suir, a lake in County Clare, and Lough Gur in County Limerick (27). Thomas Monk, in a description of County

Kildare in 1682, refers to Pike in the River Barrow (28). Edmund Spencer, author of the *Fairie Queene*, in his poem *Epithalamion*, written in 1595, refers to the "greedy pikes" of the Mulla or Awbeg River, a tributary of the Cork Blackwater (29).

Other early references to the Pike in Irish waters are given by Charles Smith (30) (for the Owenboy River, which enters the estuary of the Lee near Crosshaven), John Rutty (31) (for rivers in County Dublin), and Dr. Dudley Loftus (32) (for the River Bann). A work referred to earlier has interesting references to Pike in 1774. In Loughbricklan, we are told that "the Spawn of Pikes, finding a Passage into the Lake, multiplied so exceedingly, that they have almost destroyed" the Trout population (11). A small lake between Scarvagh and Fenwick Pass had an abundance of Pike (11). It is also stated about Lough Neagh that "of late years great numbers of Pikes have got into it and have increased prodigiously" (12).

The full story of the Pike in Irish waters is given in an earlier paper (33).

CARP *Cyprina carpio* and TENCH *Tinca tinca*

It is convenient to deal with these two species together. Robert Boyle, the world-famous scientist, in an address to the Royal Society (34) reported that his father, Richard Boyle, the first, and usually known as the Great, Earl of Cork, first introduced the Carp into Ireland. That the Earl of Cork was interested in Tench, as well as Carp, is shown in his diaries for September 1634 and September and October 1640, in which he gave orders for both fishes to be sent alive to his friends (35). Charles Smith mentions that the Owenboy River was stocked with Tench and the Awbeg River with both Tench and Carp (36). Rutty (37) repeats the statement that Carp were said to have been brought to Ireland for the first time in the reign of James I, and he points out that the two species are to be found for the most part in ponds, though Tench were to be found on rare occasions in the Rivers Liffey and Dodder. Arthur Young (38), the famous agriculturalist, who visited Ireland in the years 1776-8, writing of the neighbourhood of Lord Longford's Estate, Packenham, near Castlepollard, Co. Longford, mentions Tench in the nearby lakes. Carp and Tench in the River Barrow came there, according to William Tighe, by "the breaking down of some ponds at Low-Grange by a flood" (39).

Further details of the Carp and Tench are to be found in an earlier paper (40).

SHADS *Alosa* spp.

Geraldus Cambrensis, to whom reference has already been made (21), mentions the 'oily shad' as one of the abundant fish in Ireland. Roderic O'Flaherty (22) in 1684 states:

> "Here (Lough Corrib) is another kind of fish which have recourse to the sea as the salmon yearly to and fro, they are called chops and in Irish *trascain*, very like herrings only herrings come not into fresh water".

The History of County Down (41) unfortunately confuses to some extent the Shad and Pollan *Coregonus albula*, although the description is of the Shad, which is said to inhabit Lough Neagh. The reference is as follows:

> "This fish was for a time supposed to be a peculiar inhabitant of *Lough Neagh* but time has corrected that Error and it is now know that *Lough-Earn*, in the County of *Fermanagh*, has the same sort of Fish, though not in great Plenty; and there are also some of them in the River *Severn*, which they enter in the months of *March* and *April*. One of them was taken at *North Wall* in the River Liffy, opposite *Rings-End* near *Dublin* on 18th of *September* 1742, as a Physician, who was an Eye-witness of The Fact, assures us".

The Goaske, referred to by Sir Henry Piers in 1682 (26), in his account of County Westmeath, was probably a Shad. Piers says:

> "About Lough Iron and Lough-Direvragh there is found in the month of May only a small fish without spot, of the shape of a herring, a fish very pleasant, and delightful, but not taken in great quantities; the natives call it Goaske. I do not know any name to English it".

Seward in 1795 (18), under Lough Erne in County Fermanagh, mentions that the lake contains "a fish nearly of the shape of a herring, found only in the month of May and called Goaske", thus transferring the Goaske from Lough Iron to Lough Erne. Later Lough Iron is referred to as Lough Tron. The whole story, as told by Farran (42), is a good example of the danger of accepting references of other workers, who may not have referred back to the primary source.

STURGEON *Acipenser sturio*

The Sturgeon was always regarded as a 'royal fish'; that is to say the king had the right to receive every Sturgeon killed. A number of references to Sturgeons in Ireland are

to be found at different periods in history. All of these indicate that the Sturgeon was as scarce centuries ago as it is today.

There is an interesting story for the year 1608 (43).

> "The last of the hereditary native chiefs of Inisowen, Sir Cahir O'Doherty was insulted one day in a most open and wanton manner in the streets of Derry by the Governor, Sir George Pawlett. Incensed at the public and wanton manner of the outrage Sir Cahir returned to his native wilds and after the manner Rehoboam sought counsel of his chiefs. A remarkably fine sturgeon had just been caught and Sir Cahir was advised by the elder and more peacefully disposed of his chiefs to send it as a peace offering to the Governor of Derry".

This Sir Cahir did, and it is obvious from the nature of the transaction that the Sturgeon was a valuable fish, presumably because of its rarity.

Advertisements for Ireland (44), said to have been written in 1623, refers to the royalties of Ireland, which were of some value because "there is whales and sturgeons often taken". Richard Boyle, first (and usually called the great) Earl of Cork, received a letter dated 15th August 1624 in which Sir John Leeke stated he had sent to Boyle, under the care of Mr. Blacknoll's servant, a Sturgeon. In his own diary Boyle recorded that on 27th July 1631 Sir John Dracott sent him another fresh Sturgeon (45). These fish were both highly valued gifts.

Rutty's remarks (46) on this fish are important. He stated:

> "It is not frequent, but hath been casually found in our bay and one six feet long, and three broad at the broadest was caught in *September* 1746 between *Dublin* and the *Isle of Man* and in 1754 one was caught in a river near *Dundalk* 10 feet long and said to have been above 300 lb weight".

Clearly the fish was scarce in his day, as they were also in the time of Charles Smith, who noted in his *History of Cork* (47) that "the sturgeon had sometimes (though rarely) come into the Blackwater and Bandon Rivers".

BASKING SHARK (or SUN-FISH) *Cetorhinus maximus*

This species is perhaps best known from Robert J. Flaherty's famous film *Man of Aran*, made in 1933. However, this species was the subject of a traditional fishery until recently. Harris (48) in 1744 mentions that

> "The coasts of *Ireland*, especially those in the West,

> have of late years been much frequented by *Whales* and *Sunfish*, which come in *March* or *April* and stay till *November*. They frequent the *Herring* Bays in the fishing season and not only destroy a great number of fish but mar the fishing".

Charles Smith (49) recognised that the sun-fish of the west of Ireland was not the true Sunfish *Mola mola*, for he wrote:

> "*Mola Salv*. The sun-fish, but not the *Mola salviani* which Willoughly names the Sun-fish. Our sun-fish are from 12 to 30 feet long, and in summer months are very numerous on the coast, being seen at a considerable distance. The back fin is large, as also that of the tail. The liver affords from 20 to 100 gallons of Oyl. They are struck with harpoons, and well worth going after".

Thomas Pennant, the famous British zoologist, also recognised the difference because he wrote (50):

> "The *Irish* and *Welsh* gave it the same name, for its laying as if to sun itself on the surface of the water, and for the same reason we have taken the liberty of calling it the basking shark".

He went on to describe the liver, which he stated contained "a great quantity of pure and sweet oil"; fit for lamps, and also much used to cure bruises, burns and rheumatic complaints.

Arthur Young (51), writing of his travels in Ireland in the eighteenth century, mentioned that:

> "on the coast of Conna Marra there is, from the 10th April to the 10th May, a fishery of sun-fish, which is done by the herring boats. It is not by shares, but the owners of the boats hire the men for the fishery. One fish is reckoned worth £5 and if a boat takes three fish in the month, it is reckoned great luck".

There is considerable evidence that the fishery for the Basking Shark was very erratic, as is indicated in a recent publication (52).

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THE BREEDING BIRDS OF THE CLYDE AREA: SUPPLEMENTARY NOTES

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In 1958 I published a paper on the breeding birds of the Clyde area, which was, I believe, the first-ever attempt to give a detailed account of the breeding birds of the entire Clyde faunal area. It was also unusual in that it was the first attempt to describe and separately list all the breeding birds under the fifteen minor faunal areas of Clyde, a system which was later used for all Clyde birds in the *Regional Check-List of Clyde Birds* (1960), a second edition of which is now in preparation along with similar Regional Check-Lists for the other vertebrate classes.

During the past twenty years a good many changes have taken place, and it is hoped these supplementary notes will bring our knowledge of Clyde breeding birds up to date. It is not possible to list all changes, which would be tantamount to rewriting the original paper, and a selection has to be made, which to some extent will naturally reflect the main interests of the author. Nevertheless, I hope the following notes include all those changes which are more important or more likely to be of interest to other observers. No attempt whatever is made to repeat the information contained in the original paper, knowledge of which is assumed.

Needless to say, if anyone is aware of any other significant changes, or new records, not included in these supplementary notes, I shall be very grateful to have the information drawn to my attention.

To a large extent the purpose of the previous paper on Clyde breeding birds, and of the first edition of the *Regional Check-List of Clyde Birds*, was to seek, as much as to give, information, i.e. to set out what was known, with a view to inviting assistance with filling the gaps in our knowledge. During the past twenty years I have continued to work intensively at the breeding distribution of Clyde birds, and for extensive help over the years I am exceedingly grateful to a great many people, as follows:

- The officials and members of all major natural history societies within the Clyde area, the Scottish Wildlife Trust, Scottish Ornithologists' Club, Royal Society for the Protection of Birds, Scottish Society for the Protection of Wild Birds, and

the British Trust for Ornithology.

- Many members of the staff of the Nature Conservancy Council, Royal Scottish Museum and several regional museums, and the Forestry Commission.

- So many fellow bird-watchers who have regularly supplied me with information that it would be impractical to mention them all, but for particularly valuable help I should like to extend my special thanks to Mr. James Anderson, Mr. Duncan Colville, Mrs Margaret H. Dunn, Mr. Ian Hopkins, Mr. Edward J. Maguire, Mr. John Mitchell, Mrs Ida Rainier, Mr. David Stephen, Mr. A. Graham Stewart, and Mr. Howard Walker.

Without the generous assistance of all the above, the information contained in this supplementary paper would be very much less complete.

RED-THROATED DIVER *Gavia stellata*

A steady increase in breeding success on Arran and in all districts of south Argyll. Since early 1960s at least one pair has regularly attempted to breed at certain lochs in Renfrewshire and/or Ayrshire, but the nest is usually robbed. In 1972 a pair successfully nested on the Island of Bute and reared two young; subsequent breeding erratic owing to interference.

BLACK-THROATED DIVER *Gavia arctica*

Has nested with reasonable success on Arran for the past twenty years. At least one pair still attempts to breed from time to time in Ayrshire, but is seldom successful. In 1974 a pair bred successfully at a certain loch in West Stirling (*Loch Lomond Bird Report*, 1974), and since then breeding has been attempted most years but the birds have usually been disturbed. Breeding strongly suspected in Cowal in 1975, but no further evidence. Well established in other parts of Clyde Argyll, but breeding success erratic.

LITTLE GREBE *Tachybaptus ruficollis*

A slow but steady decrease, in some places quite marked, and in my experience the breeding population is now certainly very much less than it was twenty-five years ago. On the credit side, however, after an apparent absence of some years the Little Grebe has returned to breed in Kintyre, with a few breeding pairs known for the past few years.

BLACK-NECKED GREBE *Podiceps nigricollis*

The small colony of Black-necked Grebes which nested at

Castle Semple marsh in Renfrewshire from the early 1940s to the early 1960s has now virtually disappeared (*Western Nat.*, 3: 62-63), almost certainly because of the flooding at the loch which removed much of the suitable habitat; last breeding record apparently 1964. The Black-necked Grebe has been seen in summer at lochs in other parts of the Clyde area, but to the best of my knowledge there is nowadays no part of Clyde where Black-necked Grebes are known to breed.

FULMAR *Fulmarus glacialis*

A steady increase and spread throughout the Clyde area, and by 1970 was nesting at nearly thirty sites (*Trans. Buteshire Nat. Hist. Soc.*, 20: 53-56). In addition, since then has become established on Little Cumbrae and Inchmarnock, and this year (1979) at least one pair nested on Island of Bute. Total Clyde breeding population now certainly over 500 pairs.

MANX SHEARWATER *Puffinus puffinus*

Twenty years ago the only Clyde nesting record of the Manx Shearwater came from the island of Glunimore, near Sanda, in 1955 (*Scot. Nat.*, 1957: 53), but recent investigations have now shown that Manx Shearwaters also nest on Sanda, and very probably on all three islands of the Sanda group (*Western Nat.*, 7: 64-65). Birds have also been seen in suitable situations at Davaar, off Campbeltown, but no proved breeding so far, and a newly dead Manx Shearwater was found at the entrance of a burrow on the island of Pladda, Arran, in August 1979.

STORM PETREL *Hydrobates pelagicus*

Since 1977 has been known to nest on Sanda Island, Kintyre, where the colony has been estimated to be well over 100 pairs and possibly much higher (*Western Nat.*, 7: 63-64). Almost certainly nesting again on Ailsa Craig, but as yet no positive evidence, and proof will clearly be difficult to obtain. From the numbers being discovered in various parts of the Clyde area during the summer, by Mr. E.J. Maguire and his associates, there now seems little doubt that the Storm Petrel may nest at many more sites than was at one time supposed. Investigations are continuing.

GANNET *Sula bassana*

As expected, a steady increase in the Ailsa Craig colony over the past twenty years, from nearly 10,000 occupied nests in 1958 to some 16,000 at the present day (see *Trans. Buteshire Nat. Hist. Soc.*, 20: 57-58). Colony peaked to 17,367 nests in 1974, and fell to 12,246 nests the following year, but present

population appears to have levelled out at around 16,000 occupied nests.

CORMORANT *Phalacrocorax carbo*

A pair of Cormorants nested on Holy Island, Arran, in 1968; possibly later, but no proof. Two pairs of Cormorants were nesting in the new Shag colony at the Black Cave, Island of Arran, in 1967. Breeding was apparently attempted in 1968 and 1969, but the nests were destroyed and I know of no later record (*Trans. Buteshire Nat. Hist. Soc.*, 17: 92).

For many years Cormorants have been known to nest beside the Shag colony at the Largiebaan caves in west Kintyre, which is actually in the true faunal area of 'North Argyll', but the first published record of nesting in 'South Argyll', for those who are interested in such matters, could well be two pairs which nested in a disused fishing boat, moored in Campbeltown inner harbour, around 1930 (*Scotsman*, 11th June 1932). Long suspected to breed on Sanda group of islands, where proof difficult to obtain amongst the enormous Shag colony (*Glasg. Bird Bull.*, 5: 6), but several pairs now proved to breed there since 1976.

SHAG *Phalacrocorax aristotelis*

A fairly steady increase and spread. New Clyde nesting sites include Davaar, Holy Island, Pladda, and Inchmarnock (see *Trans. Buteshire Nat. Hist. Soc.*, 17: 92-95). A few pairs of Shags began to nest at the Black Cave, near Bennan Head, Arran in 1963. They increased fairly quickly, to seventeen nests in 1967, but in that and the next two years most of the nests were pulled out and the eggs smashed (*Western Nat.*, 4: 121). I know of no record of breeding after 1969.

GREY HERON *Ardea cinerea*

The Heron is still widely distributed over all parts of the Clyde area, but in my experience solitary nests are now much more common and nearly all the really large heronries have now disappeared, with the exception of the heronry at Gartfairn Wood, Loch Lomond, which still has in the neighbourhood of thirty nests (John Mitchell, *pers. comm.*), and Merkland Wood, near Brodick on Arran, which also has around thirty nests (*Arran Nat.*, 3: 42).

Possibly the most dramatic decrease of all has occurred on the Island of Bute, where there were formerly several heronries, one with up to twenty-five nests. For apparently the past ten years, however, there have been no Herons nesting on Bute at all, although birds are still very common and recently one nest was found.

WHOOPER SWAN *Cygnus cygnus*

Summering birds regularly reported from various parts of Clyde but still no proven breeding in the wild state, as far as I am aware.

There has been a small breeding colony of pinioned birds at Wards Farm, Loch Lomond, since the early 1960s, and with the abandonment of the wildfowl collection it remains to be seen what will happen with regard to feral breeding.

BEAN GOOSE *Anser fabalis*

A feral pair had a nest and eggs (unsuccessful) at Wards Dams, Loch Lomond in 1978 (*Loch Lomond Bird Report,* 1978), and this year (1979) successfully reared four young (John Mitchell, *pers. comm.*).

GREYLAG GOOSE *Anser anser*

Escapes from the collection at Wards Farm have now led to the establishment of a feral breeding colony at Loch Lomond, since the early 1970s. Up to sixty birds were counted in the feral flock in July 1976 (*Loch Lomond Bird Report,* 1976).

Still breeding successfully at the southern fringe of Clyde on the Ayrshire/Dumfriesshire border. Breeding at two Ayrshire lochs (*Scot. Birds,* 8: 415), with present population at least a dozen pairs.

CANADA GOOSE *Branta canadensis*

The colony at Rowbank reservoir, on the Renfrewshire/Ayrshire border (*Bird Study,* 5: 218) is now very well established, with usually up to a dozen pairs breeding each year. Elsewhere in Renfrewshire, a pair nested successfully near Kilmacolm in 1978. Following the abandonment of the wildfowl collection at Wards Farm, since about 1974 several feral breeding pairs have become fairly well established on Loch Lomond (*Loch Lomond Bird Reports*).

MANDARIN DUCK *Aix galericulata*

It was considered that escapes from the Wards Farm collection might lead to the possibility of feral breeding at Loch Lomond (*Loch Lomond Bird Report,* 1974), but so far I know of no positive record.

WIGEON *Anas penelope*

Still very scarce as a breeding species in lowland Clyde; birds occasionally seen in summer but proof of breeding difficult

to obtain. In Renfrewshire, nested at Calder Dam in 1937 and Castle Semple in 1947 (*Trans. Paisley Nat. Soc.*, 6: 63); these records were unknown to me in 1958, at the time of my original Clyde breeding bird paper. Again nested at Castle Semple in 1971 (*Western Nat.*, 3: 64). Several summer records from the Plan loch on Island of Bute within recent years, but no proof of breeding known to me.

PINTAIL *Anas acuta*

As with previous breeding records in Clyde, most summer records are usually presumed to be escapes. Recent sightings of pairs of birds in spring at Loch Lomond probably originated from three pinioned birds which escaped from the Wards Farm collection (*Loch Lomond Bird Report*, 1974).

SHOVELER *Anas clypeata*

Within recent years, some decrease noted in Renfrewshire and Ayrshire. Colonised the Island of Bute around the mid-1960s, however, and several pairs now nest there regularly at the freshwater lochs; in 1974 a pair nested at the lochan on Inchmarnock. Apparently no other nesting records known from Arran (*Western Nat.*, 4: 121) or Kintyre (*Glasg. Bird Bull.*, 7: 72) since the late 1950s.

POCHARD *Aythya ferina*

Formerly the only really good colony of Pochards in the Clyde area was at Castle Semple marsh in Renfrewshire (*Western Nat.* 3: 65), but the steady increase in flooding during recent years has gradually destroyed much of the suitable habitat and very few pairs apparently nest there now. This is a very great pity, and although one or two pairs still nest elsewhere in the Clyde area, to the best of my knowledge the Pochard can now only be regarded as a relatively scarce Clyde nesting bird.

TUFTED DUCK *Aythya fuligula*

To the best of my knowledge, no further breeding records from Kintyre (*Glasg. Bird Bull.*, 7: 72) for nearly twenty years, but several pairs now nesting at Tangy Loch, south Kintyre, since at least the mid-1970s (E.J. Maguire, *pers. comm.*).

Nesting on the Island of Bute since the mid-1950s and now well established there, with some twenty pairs nesting regularly each year at the freshwater lochs.

EIDER *Somateria mollissima*

A remarkable increase in all suitable parts of the Clyde area,

and now far and away the commonest nesting duck throughout south Argyll and the Clyde islands.

KING EIDER *Somateria spectabilis*

[A singe male has been fairly well known in many parts of the Clyde since 1971. On one or two occasions it has been seen keeping company with a female Eider and a brood of ducklings, but as far as I am aware there is no real evidence of breeding or hybridisation].

COMMON SCOTER *Melanitta nigra*

The first proof of nesting in the Clyde area came from Loch Lomond in 1971, when a female with one young was seen. A reasonably steady increase since then, and some seven pairs were estimated to be nesting in 1976. In 1977 a nest with no less than fourteen eggs was found. Breeding has been confirmed both for Dunbarton and West Stirling (*Loch Lomond Bird Reports*, 1976 and 1977).

On the fringe of the Clyde faunal area, a pair nested at Loch Awe in 1973 (*Scot. Birds*, 8: 226).

GOLDENEYE *Bucephala clangula*

For a good few years birds have been seen occasionally in summer at various lochs in the Clyde area. In 1973 a pair summered at Lochwinnoch, Renfrewshire (*Scot. Birds*, 8: 224). A pair probably summered on Loch Lomond in 1978 (*Loch Lomond Bird Report*, 1978) and I now hear from Mr. John Mitchell (*pers. comm.*) that this year (1979) a pair was seen in suitable nesting habitat on Loch Lomond in May, and a female with one young was seen in early September. To the best of my knowledge this is the first breeding record for Clyde.

RED-BREASTED MERGANSER *Mergus serrator*

A very substantial and surprising decrease in all areas, particularly so in lowland Clyde; still reasonably well known at Loch Lomond. At one time "possibly the commonest nesting duck around the shores of south Argyll and the Clyde islands" (*Glasg. Bird Bull.*, 7: 141), but now easily overtaken by the Eider.

GOOSANDER *Mergus merganser*

Some signs of a general increase and spread, particularly so at Loch Lomond, where now well established on Luss group of islands (*Loch Lomond Bird Reports*). Now nesting fairly regularly in Ayrshire. Recent proved breeding records from the River Add, near the boundary of Knapdale and Upper Loch Fyne (*Western Nat.*, 4: 99).

HEN HARRIER *Circus cyaneus*

Now very well established, with a substantial increase in breeding numbers, particularly throughout south Argyll and the Islands of Arran and Bute. One or two pairs have nested erratically in Renfrewshire and Ayrshire since at least the mid-1960s.

GOSHAWK *Accipiter gentilis*

A pair nested successfully in a certain area of Clyde Argyll in 1973 (*Western Nat.*, 4: 100); birds seen in later years but no definite proof of breeding. Birds also being seen in summer with increasing frequency in other areas of Clyde and breeding suspected, but no proof as yet as far as I know.

SPARROWHAWK *Accipiter nisus*

Now making a substantial recovery in numbers in most parts of the Clyde area.

BUZZARD *Buteo buteo*

During the past twenty years a very steady, and now substantial, increase in breeding population in all areas, particularly south Argyll and the Clyde islands. Some idea of the increase can be gained from the fact that in 1978 Mr. Eddie Maguire considered that there were nearly 100 nests throughout the Kintyre peninsula (*Western Nat.*, 8: 3-13). Twenty years ago there could hardly have been more than twenty-five nests in Kintyre. Comparable increases have been reported from other parts of Clyde; e.g. on Arran Mrs Margaret Dunn (*pers.comm.*) reports over thirty pairs of Buzzards breeding, where there were hardly a dozen in the mid-1950s.

OSPREY *Pandion haliaetus*

A pair now nesting on the fringe of the Clyde area, but as far as I am aware, not yet actually breeding within the true Clyde faunal area. With the steady increase in the number of pairs now nesting successfully throughout Scotland, however, and the large and increasing number of sightings in spring and summer from many areas of Clyde, successful breeding in Clyde can surely only be a matter of time. The Loch Lomond catchment area would appear to be the most likely prospect.

PEREGRINE *Falco peregrinus*

Very much a success story. Now well established again and increasing, with protection and the removal of much of the danger from toxic chemicals. This must be regarded as a remarkable change, since the Peregrine in the Clyde area has been saved

virtually from the brink of extinction; in 1973 two birds from West Stirlingshire were found to contain "the highest levels of Dieldrin residues ever recorded in British Peregrines" (*Loch Lomond Bird Report*, 1973). In south Argyll, particularly Kintyre, and on Arran, breeding numbers are now probably as high as at any time this century. As always, coastal sites are particularly favoured, but there are now several inland nesting sites known. At least one pair now nesting regularly on Bute.

PTARMIGAN *Lagopus mutus*

Present on the high hills of Arran since at least 1972 (*Western Nat.*, 4: 122). Proof of breeding was eventually obtained in 1977 (*Scot. Birds*, 10: 128), and several pairs now apparently nesting successfully. Still breeding on Ben Lomond and some hills of south Argyll.

"Further attempted introduction in south Lanarkshire with Braemar eggs failed" (*Scot. Birds*, 6: 84).

CAPERCAILLIE *Tetrao urogallus*

The Clyde stronghold is still the Loch Lomond area, particularly certain islands, where in 1977 breeding densities were said to be "amongst the highest in Scotland" (*Loch Lomond Bird Report*, 1977).

BOBWHITE *Colinus virginianus*

A limited introduction of the Bobwhite Quail to the Island of Arran in the early 1960s seemed to succeed for a couple of seasons, with some apparent feral breeding, but ultimately failed.

RED-LEGGED PARTRIDGE *Alectoris rufa*

Known introductions to various parts of Loch Lomondside (both Dunbarton and West Stirling) from 1973 onwards (e.g. 150 birds to Glen Fruin in 1975 - *Scot. Birds*, 9: 195) and some evidence of feral breeding; may well get established. Small introduction to Arran in early 1960s did not succeed.

CORNCRAKE *Crex crex*

Although very much reduced in numbers, to the best of my knowledge there has never been a year when Corncrakes were not recorded from at least some part of the Clyde faunal area. It is still an extremely erratic nesting species, but some years are distinctly better than others. Kintyre is still probably the best area.

LITTLE RINGED PLOVER *Charadrius dubius*

A pair nested at Merryton, Lanarkshire, on the banks of the River Clyde, in 1968 (*Scot. Birds,* 5: 282-283). This was while infilling for the construction of the new motorway had created large areas of sand and shingle. This area later became grassed over, making it unsuitable (*Scot. Birds,* 6: 86) and to the best of my knowledge the Little Ringed Plovers did not return.

GOLDEN PLOVER *Pluvialis apricaria*

A very marked decrease, and compared to twenty years ago the Golden Plover is now only a sporadic nesting species throughout much of Clyde. From some areas where it was formerly well known, e.g. the high moors of the Island of Bute, the Golden Plover has virtually disappeared altogether.

DUNLIN *Calidris alpina*

A very substantial decrease. The Dunlin is sadly reduced in many mainland areas of Clyde where twenty years ago it was fairly well known as a breeding species. Even in south Argyll and on the Clyde islands there has been a marked reduction in its breeding population.

GREENSHANK *Tringa nebularia*

The summering birds eventually left the site on Arran without any breeding being proved, and to the best of my knowledge there have been no records since 1963 (*Western Nat.,* 4: 122).

Greenshanks have been recorded in the breeding season on certain hills north of Loch Lomond (Perthshire) since 1968. Breeding was strongly suspected in 1974 (*Loch Lomond Bird Report,* 1974) and was eventually proved in 1977 (M. Davies, *unpublished N.C.C. Report*). This, however, was not actually the first Clyde breeding record, as was thought at the time, since there are previous records of Greenshanks nesting in Upper Loch Fyne (1830s) and Kintyre (1924), on the fringe of the Clyde faunal area (*Supplement to the Birds of the Firth of Clyde,* 1959).

BLACK-HEADED GULL *Larus ridibundus*

An enormous decrease, and now very few colonies indeed with over a hundred pairs. The well known and formerly gigantic colonies at Castle Semple, Flanders Moss, and the Endrick Mouth, and other extremely large colonies on Lady Isle, Horse Island, Loch Macaterick, Loch Urd, and several other places, are now all but virtually deserted.

The Black-headed Gull is still extremely common all over

Clyde, with an enormous roost on the Renfrewshire foreshore, near Longhaugh Point, which at times must number well over 10,000 birds, plus other extensive roosts at Balgray Dam, Fannyside Loch, Doonfoot, and Barassie. As a breeding species, however, the Black-headed Gull has undergone far and away the most dramatic decrease of all Clyde birds.

GREAT BLACK-BACKED GULL *Larus marinus*

The large colony at the Boguillie hill lochs on Arran, which at nearly 100 pairs was the largest colony in Clyde, has now been completely deserted, following persistent persecution (*Trans. Buteshire Nat. Hist. Soc.*, 18: 26; *Western Nat.*, 4: 123). Its stronghold, however, is still south Argyll and the Clyde islands, where it is clearly holding its own, and elsewhere it is slowly extending its range. Nested at Loch Thom, Renfrewshire, in 1970 (apparently for the first time) and intermittently since then.

KITTIWAKE *Rissa tridactyla*

Still a very large colony on Ailsa Craig, although some decrease in population and the size of the Ailsa colony is now around 5,000 pairs.

I have no recent information about the small colony on the Mull of Kintyre cliffs. This is a difficult and hazardous site, which can only be inspected properly from the sea very close under the cliffs, and to the best of my knowledge has not been visited for the past seven years, when there were about a dozen nests. The colony on the Sanda group of islands has steadily decreased, and there are now barely a dozen pairs nesting over all three islands.

Kittiwakes were erroneously recorded as nesting on the Little Cumbrae in the *Third Statistical Account* (1962); this was an obvious mistake for the Common Gull. Much more serious, however, is the error in the B.T.O. *Atlas* (1976) which records two totally non-existent Kittiwake colonies on Arran. This appears to have been a clear mistake for Fulmars, which occupy the stated sites, and it is a very great pity this was not checked before publication.

SANDWICH TERN *Sterna sandvicensis*

As with the Roseate Tern, a vast decrease. Even the two Clyde strongholds of Lady Isle and Horse Island, which until some ten years ago had colonies each of around a hundred pairs (*Trans. Buteshire Nat. Hist. Soc.*, 17: 89-90) are now reduced to a few nests.

A pair which nested in the tern colony at Ballantrae in 1975

was claimed as the first record (*Scottish Wildlife*, 11(3): 22), but there are previously published records of nesting there in 1941 (*Glasg. Nat.*, 14: 96), in 1946 (*Glasg. Bird Bull.*, 7: 51,150) and in 1950 (*Trans. Buteshire Nat. Hist. Soc.*, 17: 90).

It was reported that a pair of Sandwich Terns nested on One-Tree Island, Loch Riddon, in 1971 (*Scot. Birds*, 7: 143) but this record was not confirmed by other observers who visited the island that summer, and to the best of my knowledge none has been seen there since.

ROSEATE TERN *Sterna dougallii*

Unfortunately the Roseate Tern has now been extinct, or virtually so, as a Clyde breeding species for nearly ten years. One or two birds can occasionally be seen in summer at their former haunts, but to the best of my knowledge any suggestion of recent breeding is extremely doubtful. In addition to the well known nesting sites on Lady Isle and Horse Island, Roseates nested on Pladda in the 1960s, but apparently got swamped when the Black-headed Gull colony increased. A few pairs also nested at Carskey Bay, south Kintyre, in the mid-1950s, but sand and gravel removal eventually put the entire site out of existence.

"The year 1969 was the first time for twenty-five years that I had not personally seen a Roseate Tern's nest somewhere in the Clyde area" (*Trans. Buteshire Nat. Hist. Soc.*, 17: 87). I have seen very few since.

COMMON TERN *Sterna hirundo*

A very pronounced decrease within recent years. Common Terns have nested at nearly a hundred sites within the Clyde faunal area (see *Trans. Buteshire Nat. Hist. Soc.*, 20: 61-67) and until some ten years ago about half of these were occupied fairly regularly, with varying populations. Now there only appear to be some half-dozen regularly occupied nesting sites, and even here the numbers are very small. Even the formerly substantial colonies on Lady Isle, Horse Island, and Pladda are now reduced to a handful of nests each.

ARCTIC TERN *Sterna paradisaea*

As with the Common Tern, a most remarkable decrease and now virtually reduced to a handful of pairs on Inchmarnock, Pladda, Lady Isle and Horse Island. Oddly enough, despite this decrease elsewhere in Clyde, in 1977 one pair, and in 1978 two pairs bred at the Endrick Mouth, Loch Lomond, on the Stirlingshire bank of the river. This was apparently the first recorded breeding of the Arctic Tern for West Stirlingshire, and the first recorded

breeding for Loch Lomondside this century (*Loch Lomond Bird Reports*, 1977 and 1978).

LITTLE TERN *Sterna albifrons*

Still nesting in only two areas of Clyde - Ayrshire and Kintyre - although it now seems likely that Robert Gray's old record of nesting on Inch moan, Loch Lomond, last century was probably correct.

Small colonies still well established at Ballantrae, Ayrshire and Rhunahaorine, Kintyre. Both of these sites are now reserves of the Scottish Wildlife Trust. Nested at Carskey Bay, Kintyre, from late 1950s to early 1960s, but site ultimately destroyed by sand and gravel extraction. For details of all three colonies see *Trans. Buteshire Nat. Hist. Soc.*, 18: 88-89.

Little Terns were recorded as nesting on Lady Isle in 1934 (Scottish Society for the Protection of Wild Birds, *Annual Report*, 8: 22). In 1977 two pairs nested on Horse Island (*Birds*, 6(9): 42).

BLACK GUILLEMOT *Cepphus grylle*

For a detailed list of the breeding sites of the Black Guillemot in the Clyde area see *Trans. Buteshire Nat. Hist. Soc.*, 17: 82-84. In 1969 there were at least ten nesting sites, with a total breeding population of about 100 pairs, compared to some fifty pairs ten years ago. The stronghold of the Black Guillemot in the Clyde area is undoubtedly the Sanda Island group, which holds about half the total Clyde population. Recently the Pladda colony has also increased, to about a dozen pairs.

There is clear evidence of extension of range. New breeding stations are Inchmarnock, where up to three pairs have bred since 1976, and Bennane Head, Ayrshire, where a few pairs have bred since at least 1970. Adults and a juvenile seen off Ardmore, Dunbartonshire, in autumn 1976 may be an indication of breeding, but no later records known to me. During the past year there have been reports about possible nesting at a Renfrewshire shipyard; confirmation still awaited.

STOCK DOVE *Columba oenas*

A steady decrease in most parts of the Clyde area, but particularly so towards the west. No breeding records for the Island of Bute for the past ten years, and any recent records from Arran are doubtful. Even in Kintyre, where the Stock Dove was once fairly well known, it is now uncommon and local. I know

of no recent proved breeding from any other part of Clyde Argyll.

COLLARED DOVE *Streptopelia decaocto*

First proved to nest in the Clyde area in Ayrshire, in 1959 or possibly some two years earlier (*Scot. Birds,* 1: 125). Since then a steady and fairly rapid spread, in common with most parts of the country. Now nesting all areas of Clyde, including the Islands of Arran, Bute and Cumbrae, and steadily increasing in numbers.

LONG-EARED OWL *Asio otus*

A very substantial decrease in all areas during the past twenty years, and now sadly reduced even in some of its formerly well known haunts. A few pairs do nest locally in most areas, but this is a most remarkable change.

NIGHTJAR *Caprimulgus europaeus*

Still nesting in some numbers on the Island of Arran, and also on Bute, but has virtually disappeared as a nesting species from the lowland counties. Even throughout south Argyll it is substantially reduced in numbers.

SWIFT *Apus apus*

Certainly a steady reduction, and although still present in reasonable numbers, recent proved nesting in some areas (e.g. Arran and Knapdale) now very doubtful, although birds always present during the summer.

KINGFISHER *Alcedo atthis*

A few pairs now nesting again in the lowland counties of Renfrew, Ayr and Lanark. Nesting again on the Island of Arran, and in 1976 was proved to nest on the Island of Bute, from where there is now good reason to believe that Kingfishers also nested in the early part of this century. A full report on the Bute Kingfishers will shortly be published in the *Transactions of the Buteshire Natural History Society*. Also some evidence of returning to nest in Highland Clyde. Nesting attempted at River Endrick, Loch Lomond, in 1978, and in the early 1970s good evidence of at least one pair nesting again in Kintyre.

GREEN WOODPECKER *Picus viridis*

After many years of 'prospecting' several parts of the Clyde area, apparently first proved to nest in Clyde, in Lanarkshire, in 1961 (*Scot. Birds,* 1: 454). From then on a slow but steady increase and spread, and by late 1960s known to be nesting in

small numbers in parts of Lanarkshire, Ayrshire and Dunbarton. By early 1970s breeding was also well established in certain areas around Loch Lomond, and Renfrewshire nesting almost certain by mid-1970s. Birds also seen in summer in other parts of the Clyde, including south Argyll, but to the best of my knowledge breeding not yet proved. As yet, no evidence of breeding on the Clyde islands.

GREAT SPOTTED WOODPECKER *Dendrocopos major*

In contrast to the spread of the Green Woodpecker, the Great Spotted Woodpecker has steadily decreased and contracted its range during the past twenty years. This is particularly noticeable in Renfrewshire and on the Island of Arran, in some parts of which it was formerly particularly common, and also on the Island of Bute. At present the Great Spotted Woodpecker can only be regarded as a very local nesting species in Clyde.

SAND MARTIN *Riparia riparia*

The largest colony of Sand Martins in the Clyde area is almost certainly the colony at Drumbeg sand quarry, near Drymen, which was estimated at over 600 pairs in 1975 (*Loch Lomond Bird Report*, 1975). This has overtaken the other famous colony at Rosebank, Lanarkshire, which numbered over 400 nests in the early 1950s (*Scot. Nat.*, 1952: 175), but land reclamation work at the Drumbeg quarry had reduced the Drumbeg colony to some 350 pairs by 1977 (*Loch Lomond Bird Report*, 1977).

HOUSE MARTIN *Delichon urbica*

It is probably worth recording that recent clearing and painting work on the eaves of the hotel has now put the once enormous House Martin colony at Turnberry Hotel, Ayrshire (*Glasg. Bird Bull.*, 7: 66-67) virtually out of existence.

YELLOW WAGTAIL *Motacilla flava*

Consolidating its position slightly as a nesting species in Renfrewshire and Ayrshire. Still nothing like so common as it was before the war, but a marked improvement on the position twenty years ago.

REDWING *Turdus iliacus*

Although summering birds have now been recorded for some years from various parts of the Clyde area, to the best of my knowledge there has never been any real evidence of breeding. The best claim, only of possible breeding, would appear to be that of one singing in Arrochymore Wood, West Stirling, on 20th May 1976 (*Loch Lomond Bird Report*, 1976).

GARDEN WARBLER *Sylvia borin*

Still fairly well distributed in lowland Clyde, but marked decline in status on the Clyde islands. Numbers much reduced on Arran, and for the past ten years no apparent breeding record at all from the Island of Bute, where at one time it was reasonably well known, even if thinly distributed.

On the credit side, however, now definite evidence of a few pairs nesting in south Kintyre (E.J. Maguire, *pers. comm.)*.

BLACKCAP *Sylvia atricapilla*

Still fairly well distributed in lowland Clyde, but to the best of my knowledge has completely vanished as a nesting species from the Island of Bute, the only Clyde island on which it had ever been proved to nest. It was never very common, but I know of no indication of breeding on Bute for at least fifteen years.

Now also known to be nesting in south Kintyre in small numbers for the past few years (E.J. Maguire, *pers. comm.*). This may well be the first proved breeding for Kintyre. Also reported to be breeding in south Knapdale (*Western Nat.*, 4: 110).

PIED FLYCATCHER *Ficedula hypoleuca*

For some years now, known to nest regularly and widely around Loch Lomondside, including some of the Loch Lomond islands. A marked increase in breeding population was recorded in 1976 (*Loch Lomond Bird Report,* 1976).

WILLOW TIT *Parus montanus*

A bird was seen carrying food at Strathblane, West Stirling, on 22nd June 1977 (*Loch Lomond Bird Report,* 1977). As far as I am aware, this possible breeding record is quite new for this area of Clyde.

NUTHATCH *Sitta europaea*

Isolated records of single birds from Knapdale and Upper Loch Fyne during past twenty years (*Western Nat.*, 4: 108). No nest ever found, but during summer 1976 one bird seen several times carrying food, near Lochgilphead (Mrs Ida Rainier, *in litt.*).

JAY *Garrulus glandarius*

During the past ten years or so the Jay has returned to Ayrshire, and a few pairs now breed locally. Since the mid-1970s a very few pairs have been known to nest in the wooded areas of north Kintyre (E.J. Maguire, *pers. comm.*). To the best of my knowledge this is the first-ever definite breeding

record for Kintyre (see *Glasg. Bird Bull.*, 7: 80).

MAGPIE *Pica pica*

Still nesting commonly in the usual lowland areas, although breeding can be surprisingly local. Apart from Cowal, where local but regular, still virtually unknown as a breeding species throughout the rest of south Argyll, although an increasing number of sightings in the new forestry plantations probably indicates that successful breeding may not be too long delayed. A suggestion in 1967 that breeding in Cowal was a recent extension (*Scot. Birds*, 4: 449-450) was quite incorrect, since the Magpie has been well known to nest in Cowal regularly, if locally (*Glasg. Bird Bull.*, 7: 28; *Scot. Birds*, 5: 65), for at least fifty years. A few pairs still manage to nest on Bute despite constant persecution.

CHOUGH *Pyrrhocorax pyrrhocorax*

Small breeding population now well established at Mull of Kintyre. Birds regularly seen elsewhere in Clyde, particularly in other parts of Kintyre and on Arran, but no real evidence of breeding. Recent suggestion of nesting on Bute very doubtful.

SISKIN *Carduelis spinus*

Now known to nest regularly throughout suitable parts of Kintyre and Knapdale. Also nests fairly regularly on Arran, and recent positive breeding records from Bute and Cowal. Still rather sporadic in lowland Clyde, but increasing. It is worth noting that, just on the fringe of the Clyde area, over 100 pairs were said to be nesting in the Carron Valley Forest in 1977 (*Scot. Birds*, 10: 150).

CROSSBILL *Loxia curvirostra*

Within past two years successful breeding reported from Ayrshire and Renfrewshire. In 1977 a pair almost certainly bred in Garadhban Forest, near Drymen (*Loch Lomond Bird Report*, 1977). Behaviour strongly indicated that breeding had taken place, and on 1st April one juvenile was seen. There does not appear to be a previous breeding record for Loch Lomondside, at least this century. Also in 1977, some twenty pairs were said to be breeding in the nearby Carron Valley Forest (*Scot. Birds*, 10: 151). This is on the fringe of, and overlaps into, the Clyde faunal area.

HAWFINCH *Coccothraustes coccothraustes*

A pair nested near Girvan, Ayrshire, in 1970 but the five

eggs were destroyed by boys (*Scot. Birds*, 8: 279). As far as I know, the only other possible evidence of breeding within the true Clyde faunal area also comes from Ayrshire, in 1939 (*Ayrshire Arch. Nat. Hist. Coll.*, 1*NS*: 115).

CORN BUNTING *Miliaria calandra*

In common with most parts of the country, a very marked decrease as a breeding species in all areas, and now nearly extinct in many previously well known haunts. To the best of my knowledge, the only areas of Clyde where Corn Buntings still appear to breed in anything like their former numbers are Knapdale (*Western Nat.*, 4: 113) and some localised areas of Renfrewshire and Ayrshire in lowland Clyde.

I trust that the above notes on seventy-five selected species include all really significant changes, but in addition, certain other species have undergone what would appear to be more localised or restricted changes, as follows:

Birds which have also shown some evidence of increase as Clyde breeding species during the past twenty years include the Golden Eagle, Kestrel, Lesser Black-backed Gull, Herring Gull, Woodpigeon, Short-eared Owl, Tree Sparrow, and Goldfinch.

On the other hand, some decrease in breeding status has been recorded for the following: Great Crested Grebe, Merlin, Red Grouse, Partridge, Coot, Guillemot, Razorbill, Barn Owl, Ring Ouzel, and Whitethroat.

During the past twenty years a few species declined markedly for some time but then increased again to more or less their former status. The most notable example is probably the Black Grouse, but other species which could come into this category include the Lapwing, Redshank, and Stonechat.

As far as I am aware, there have been no really material changes recorded amongst the remaining species included in the original 1958 list.

In general terms, therefore, during the past twenty years we would appear to have gained the Common Scoter and the Green Woodpecker as completely new regular Clyde Breeding species. As far as I know, there are no other examples, although the Goshawk, Little Ringed Plover, almost certainly Nuthatch, Hawfinch, one rarity (suppressed), and a few feral or escaped birds, have nested on isolated occasions but have not (yet) become established.

The only species we have genuinely lost during the past

twenty years appear to be the Black-necked Grebe and the Roseate Tern, but at best these have always been somewhat erratic in any of their breeding haunts, even although for many years they appeared to be well established at their Clyde breeding sites. They may yet return.

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BREEDING BEHAVIOUR OF OPHIOCOMINA NIGRA (ABILDGAARD) IN THE FIRTH OF CLYDE

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Introduction

Information regarding the breeding of echinoderms is very scant. Some workers (Elmhirst, 1922; Narasimhamurti, 1933; Thorson, 1946; and Boolootian, 1966) have used loose criteria such as the presence of young larvae in the plankton, and the presence of ripe ova in the ovaries, to delimit breeding seasons. Other workers (Taylor, 1958; Fenaux, 1970; Crump, 1971; and Holland, 1967) have used histological techniques to study the seasonal state of the gonads, and in some cases have developed mathematical techniques for standardising this type of approach. Both Jensen (1969) and Gonor (1972) have studied the data of the fresh gonads, either as squash preparations or by taking representative sections through the gonads. These latter techniques, though an improvement on the former, cannot place the actual breeding time with any precision. Elmhirst (1922) reports that *Ophiocomina nigra* breeds at Millport during May, June, October and November. Boolootian (1966), who summarises the literature on *O. nigra*, records that off Plymouth it breeds from mid-June to mid-September, and his list of breeding seasons for this species suggests that the breeding season is extended with latitude decrease.

Materials and Methods

The *Ophiocomina* bed at Keppel Pier was studied in detail by scuba diving from March through to July in 1972 and 1973. A series of physical factors, including the state of the tide, the weather conditions and seasonal variables such as hours of daylight and sea temperature were measured, in order to investigate possible factors involved in spawning. Daily records were kept of the maximum wind, estimated using the Beaufort wind scale, and the state of the sea was estimated using the international sea scale. Hours of daylight were calculated from the times of sunrise and sunset in Glasgow. In order to gain an index of the amount of light during any one day, duplicate 'light bottles' containing 25 mls potassium iodide (10 gm/litre) and sulphuric acid were placed daily in open ground some 300 metres from Keppel Pier. Each day after sunset the resulting iodine was titrated

against 0.001N sodium thiosulphate. This experiment was run in conjunction with G. Hinton of the Department of Botany, Glasgow University.

For quantitative measurements of gonads, the first four gonad lobes to be teased out were measured using a microscope with a micrometer eyepiece, and the mean lobe-length and disc diameter were recorded.

In order to obtain a measurement for intensity of mating on the sea bed, an area of two square metres was lined off using orange corlens string.

Sea temperatures were taken from the records at the Marine Biological Station at Millport.

Gross anatomy of the Gonads

The sexes are separate in *Ophiocomina* and hermaphroditism was not recorded by the author. Prior to spawning the gonads may be exposed by dissection in all specimens with a disc diameter greater than 4 mm. Small specimens were difficult to dissect, and also rare in the Keppel population. In small specimens the gonads are spherical, but in large ones - e.g. those with a disc diameter greater than 8 mm - they consist of many finger-like projections. The testes are pale pink. All males with a disc diameter greater than 4 mm had motile sperm. The ovaries are bright orange. After spawning the testes become wrinkled and acquire a scarlet colouration caused by clusters of amaebocytes on the outer wall. The spent ovaries contained a few brown ova, with a blackish fluid, possibly break-down products of pigment, in the lumen. With experience it became possible to sex brittlestars on the sea bed both before and after spawning by merely slitting open a bursa with a knife.

If *O. nigra* was placed in sea-water stained with toluidine blue, uptake of the dye was discernible between the gonad lobes. This was not due to intrusions from the stomach, because the dye was not taken up by the gut. It suggests that diverticula from the bursae pass into the gonads. The lobes of the gonads open directly into the bursae; thus the diverticula probably do not serve a reproductive function.

Sexual Structure of Populations

Table 1 shows the mean disc diameter of males and females at three stations. It can be seen that there is no great difference in size between the sexes.

Table 1	Mean Disc Diameter (mm)	
Site	Male	Female
Fairlie	18.23	18.54
Keppel Pier	10.85	11.10
Balloch Bay	7.04	8.56

The percentage of males and females in various populations is shown in Table 2. The sex ratio is approximately equal.

Table 2

Site	Number Males	Number Females	% Males	% Females
Fairlie	35	44	44	56
Red Buoy	640	545	54	46
Keppel Pier	264	244	52	48
Balloch Bay	25	18	58	42

Mating Behaviour 1972

The Sea temperature during February and March ranged between 6.0 and 7.4°C. In April it began to rise, and mating behaviour was first observed on 25th April, when the temperature had risen to about 8.0°C. Large ophiuroids were associated with smaller ones, the latter ('riders') gripping the former ('carriers') by their arms, which were folded tightly over the discs of the carriers in the inter-ambulacral area. As regards their position, riders were of two types: those carried orally and those carried aborally on their partners. The aboral riders were carried singly, and the oral riders singly or with a variable number of secondary riders. Of 823 riders examined all but one were males. Figure 1 shows an oral association, the carrier being turned over to enable the position to be seen clearly.

Fifty-nine percent of the carriers in aboral associations

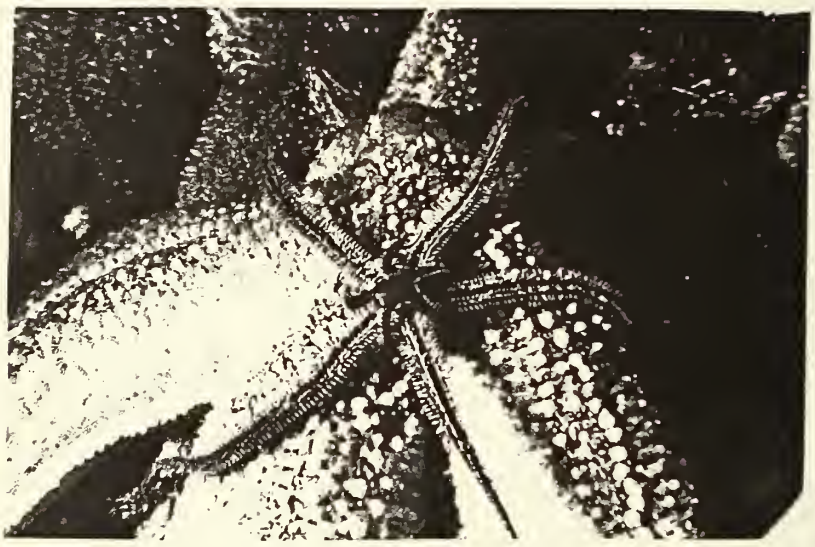

Figure 1.

Photograph of an oral male rider on a female carrier at Keppel Pier in May 1973. This association has been turned over by the author, and is lying on *Asterias rubens*. The rider is in a mouth-to-mouth position with the carrier, with his arms folded tightly between the interambulacra of the carrier and meeting on the aboral surface of her disc.

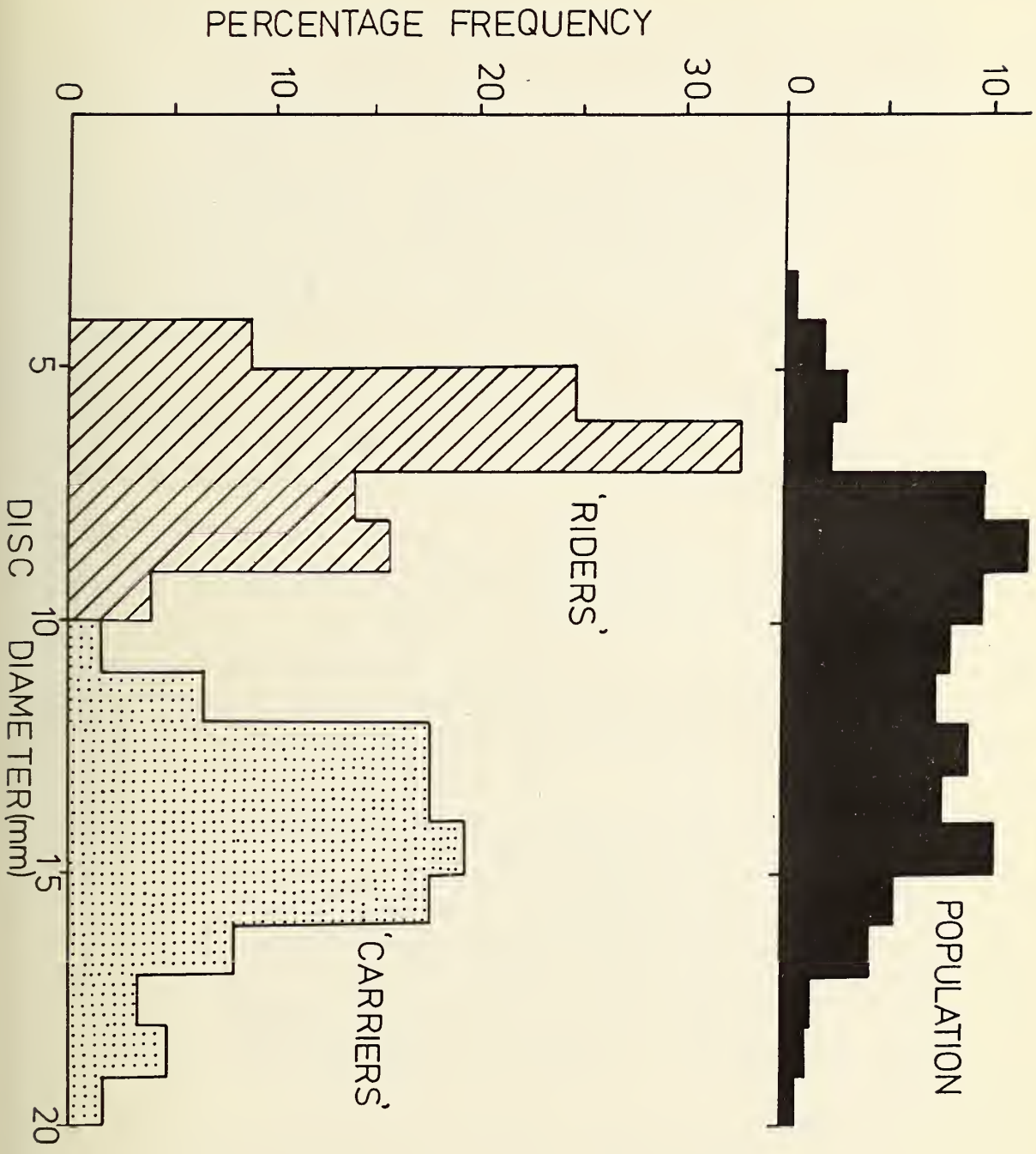

Figure 2. The size-frequency distribution of male riders and female carriers compared with the size-frequency distribution of the population during the mating season in 1972.

were females, and 89% of the carriers in oral associations were females. In addition to the primary rider of the oral association, up to eight secondary riders occurred. These gripped the carrier in a similar fashion to the primary rider, although their position on the disc was variable. Of 70 oral associations examined, 66% of the carriers had no secondary riders; 20% had one, and 14% had between two and eight. It was thought that the aboral associations represented primary mounting, essentially at random, and that oral associations perhaps represented copulation, in view of the juxtaposition of the bursae of carrier and rider. The disc diameters of the female carriers ranged from 11-20mm with a mean of 15.0 mm, and those of the male riders ranged from 5 - 10 mm, with a mean of 7.2 mm. The size-frequency distributions of male riders and female carriers compared with that of the populations are shown in Figure 2. It can be seen that the riders are a size class which is poorly represented in the overall population, whereas the carriers are essentially that part of the population with a disc diameter larger than 11mm.

In order to test whether there was any correlation between the relative sizes of riders and carriers, the disc diameter of male riders was plotted against that of the female carriers (Figure 3), but no correlation was found.

To investigate the possibility of large females attracting more riders, the mean riders per carrier was plotted against the disc diameter of the female carriers, but this again showed no significant relationship (Figure 4).

The period over which sexual behaviour was observed is shown in Figure 5. Females began to shed ova in the laboratory on 16th June. By 19th June all animals from the field had spent gonads, and sexual behaviour had ceased. There was some indication that the intensity of mating, as indicated by the mean riders/carrier, had risen towards the end of this period; 1.44 on 23rd May as against 3.25 on 15th June. The mean number of associations/square metre of the sea bed appeared variable, so it was planned to examine both these parameters in greater detail in 1973.

The mean gonad lobe length of females and males before (17th May 1972) and after (19th June 1972) spawning are summarised in Figures 6 and 7. The whole population spawned, including small females and large males which had not shown the sexual behaviour described above. If spawning in the field also started on 15th June, then it occurred between three and six days before the summer solstice, and nine before the full moon.

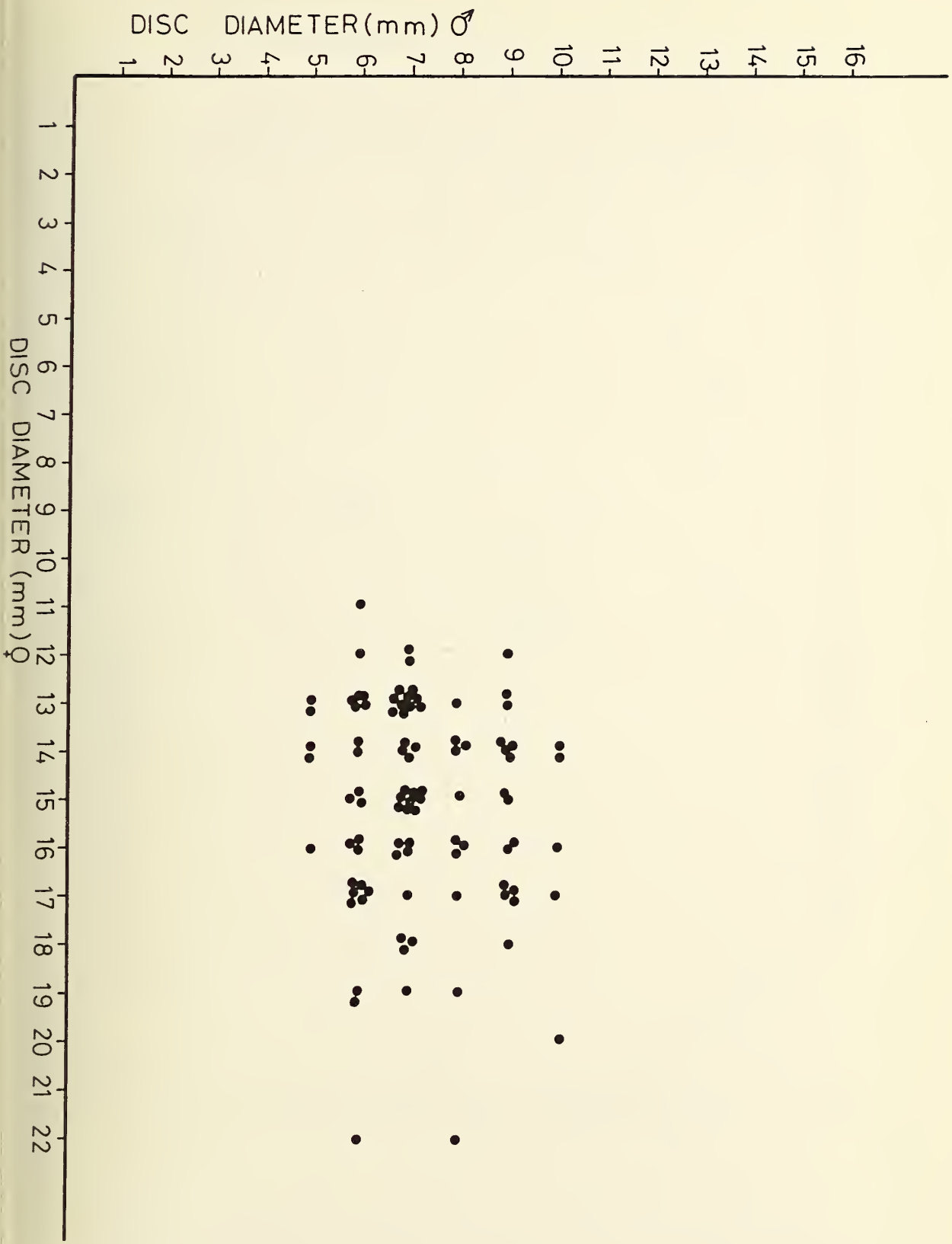

Figure 3. Scatter diagram showing the relationship between the size of male riders and female carriers.

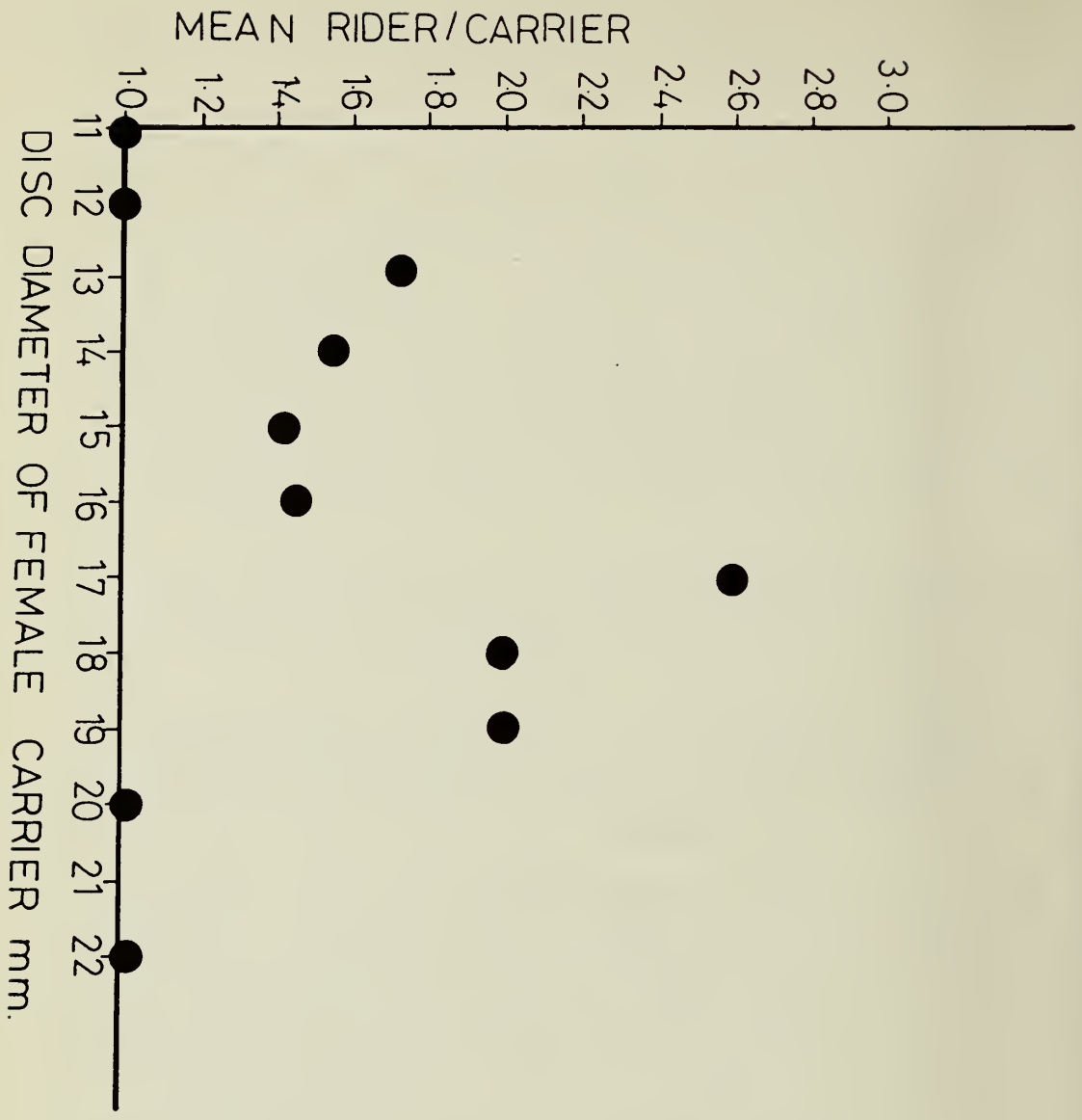

Figure 4. The mean number of riders/carrier plotted against the disc diameter of the female carriers.

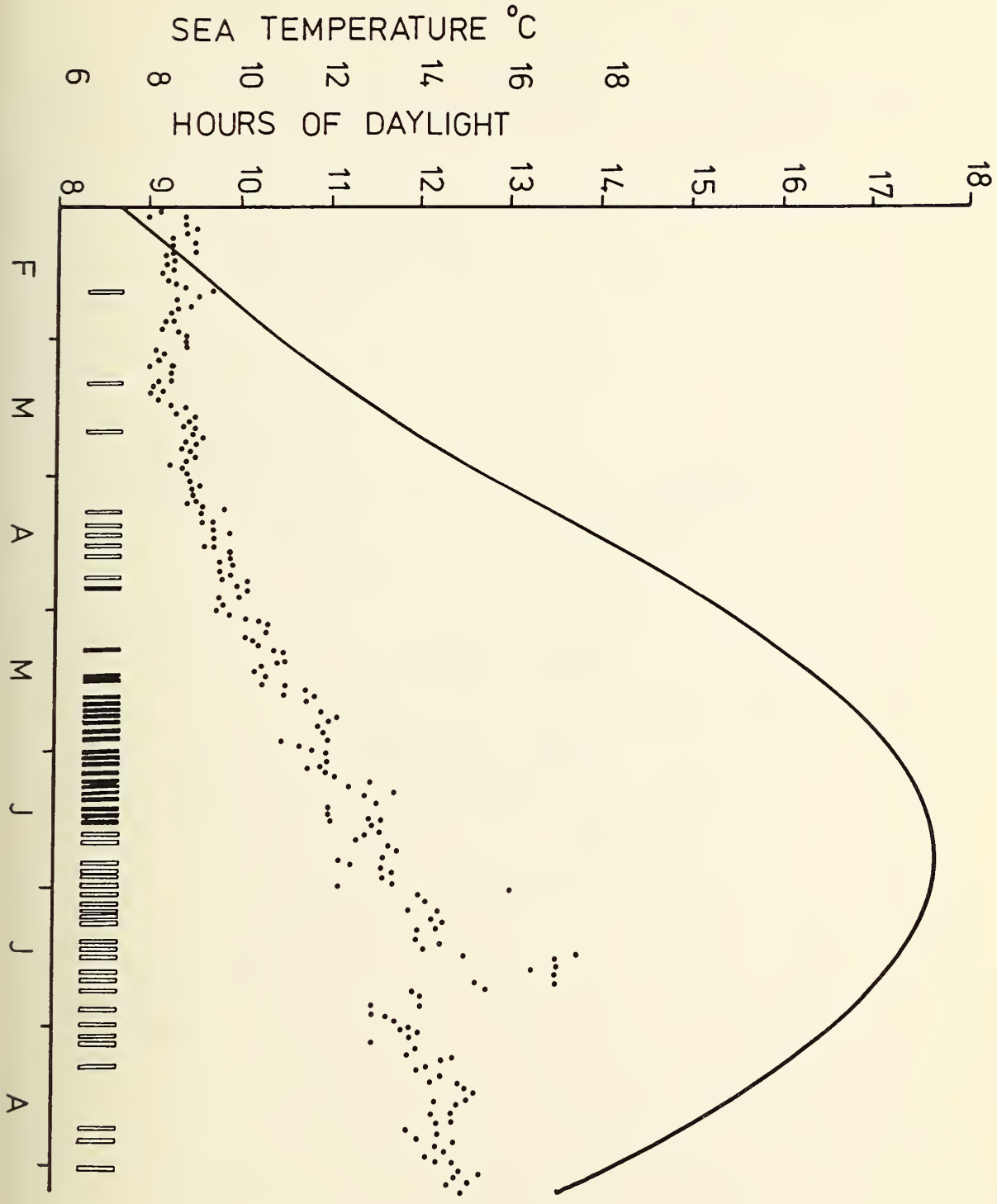

Figure 5. The occurrence of mating at Keppel. Empty bars indicate dives during which no mating was observed. Solid bars indicate observation of mating. Dots show daily sea surface temperature. Solid line indicates hours of daylight.

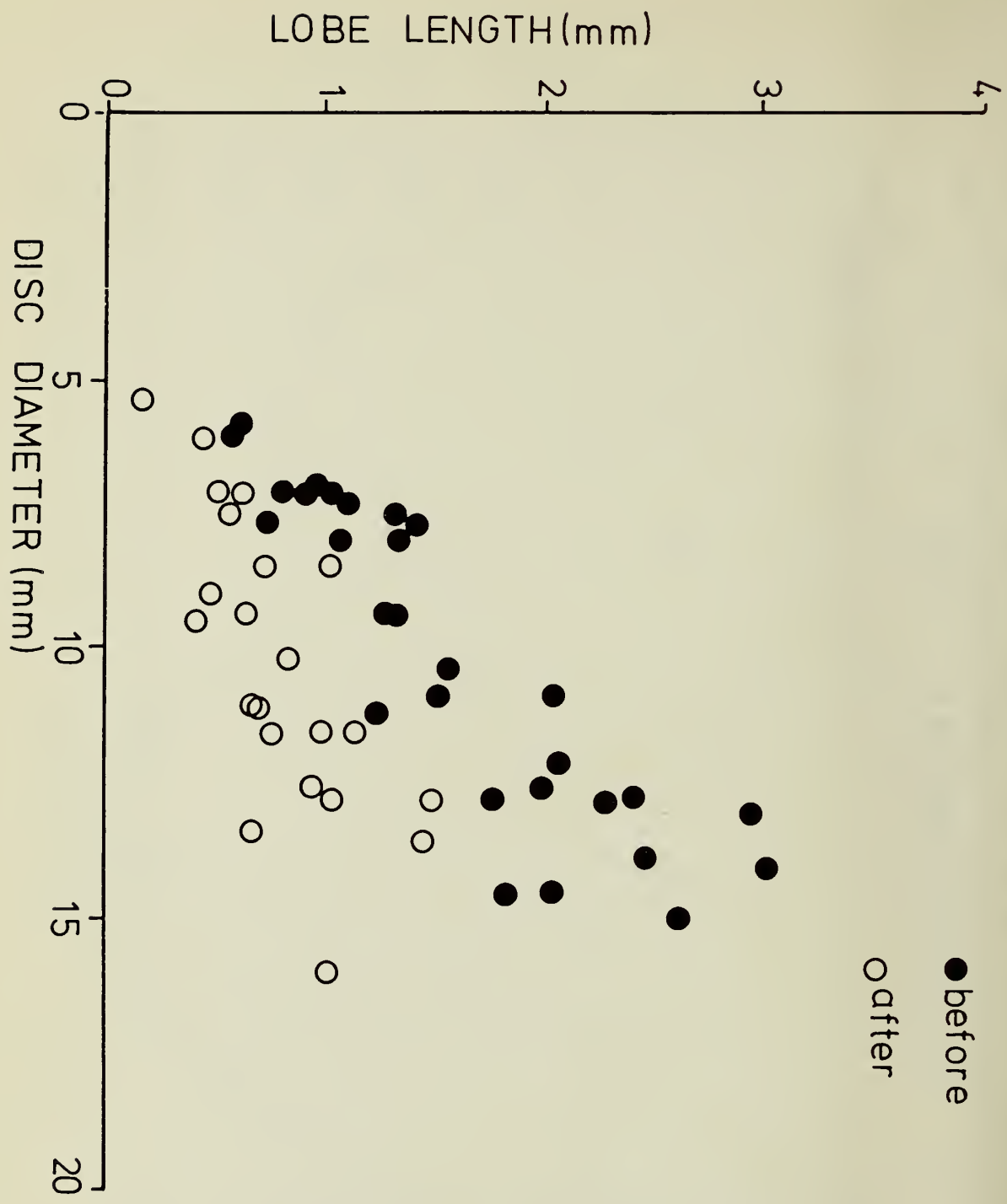

Figure 6. The mean lobe length of the ovaries plotted against disc diameter before and after spawning.

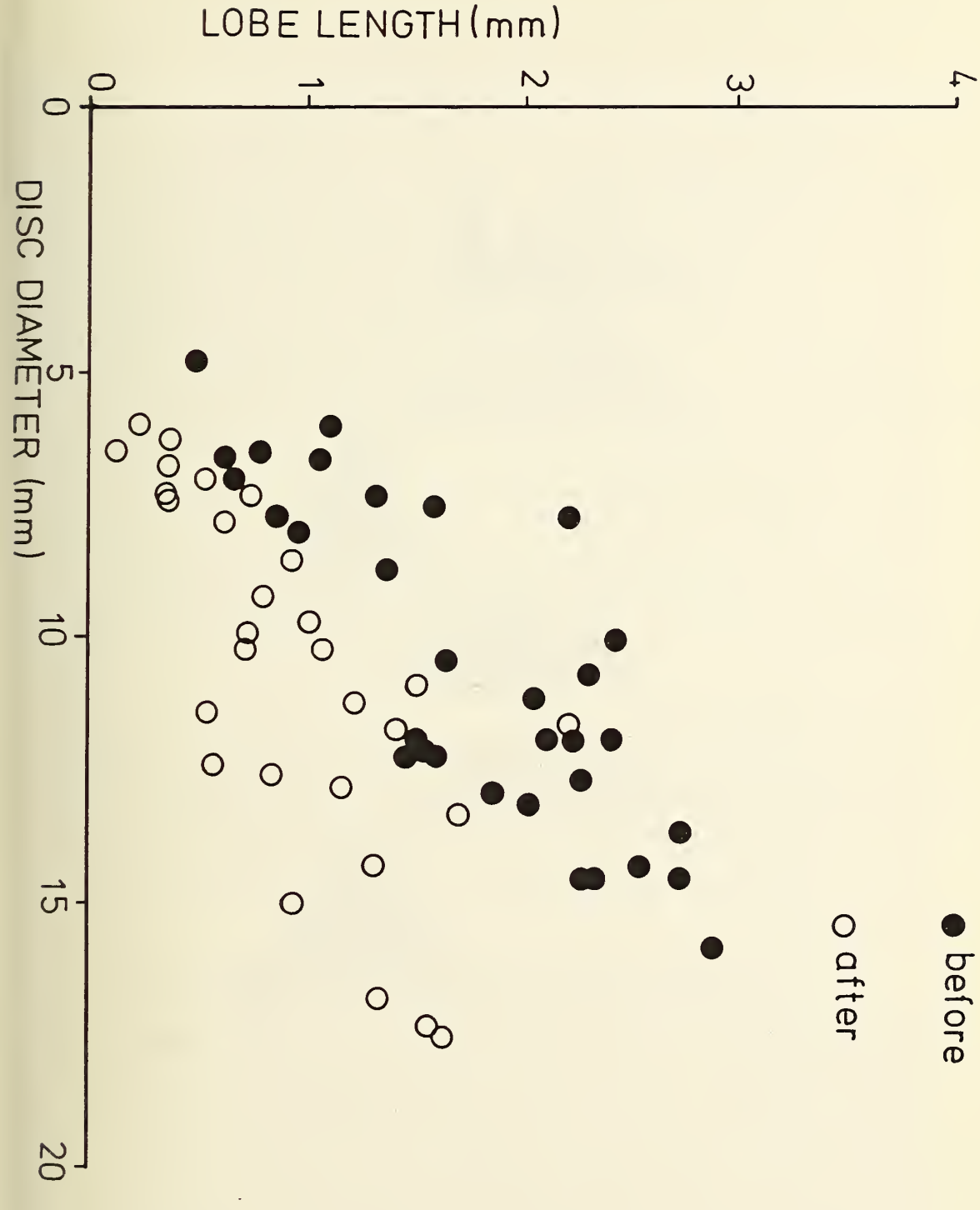

Figure 7. The mean lobe length of the testes plotted against disc diameter before and after spawning.

Laboratory Experiments

Prior to spawning a number of experiments were performed in the laboratory. On only one occasion did mating occur spontaneously in the laboratory, during April 1973.

Mating associations brought in from the field would dissociate within 24 hours and not re-form. Ten associations were hand collected during diving. The males were prized off and the brittlestars separated into two batches of five female carriers with ten riders in each batch. One batch was placed in a beaker of still sea-water, and the other in a similar beaker with a current of sea-water flowing through. After four hours, four carriers and seven riders had reassociated in the still water; in the flowing water only two riders and two carriers had associated, but the flowing water experiment could merely have inhibited movement in the males, slowing down the rate of re-association. It is possible, however, that there is a chemical attractant from the female. Some crude experiments were attempted, adding crushed ovaries or testes to the still sea-water in order to see if associations would re-form at a different rate, but no change in the rate was observed. It was observed, however, that a male whose testes had been ruptured by a needle was mounted by other males. The grip of the male appears to squeeze the ovaries of the female until they begin to protrude through the bursal slit.

Mating Behaviour 1973

It was considered in 1972 that aboral associations represented accidental mounting at random, and that oral associations essentially consisted of small males mounting large females, the 11% occurrence on large males representing sexual error on the part of the riders. More detailed examination in 1973, however, revealed that these conclusions were possibly an over-simplification, and did not do justice to the extent of male to male partnerships.

Of 215 associations examined, 66% were aboral. Of these aboral associations, 60% of the carriers were male. Of 265 oral associations examined, 35% were male carriers. Figure 8 shows the size-frequency distributions of male riders, male carriers and female carriers in aboral and oral associations. The mean disc diameters of both male and female carriers were approximately the same (about 14mm), and those of the male riders in both types of associations were also similar (about 7 mm). This picture was the same as for 1972, and indicated that riders show no preference for any particular size of male or female carrier in either oral or aboral associations. In order to study the intensity of mating in more detail in 1973, the number of brittlestar assoc-

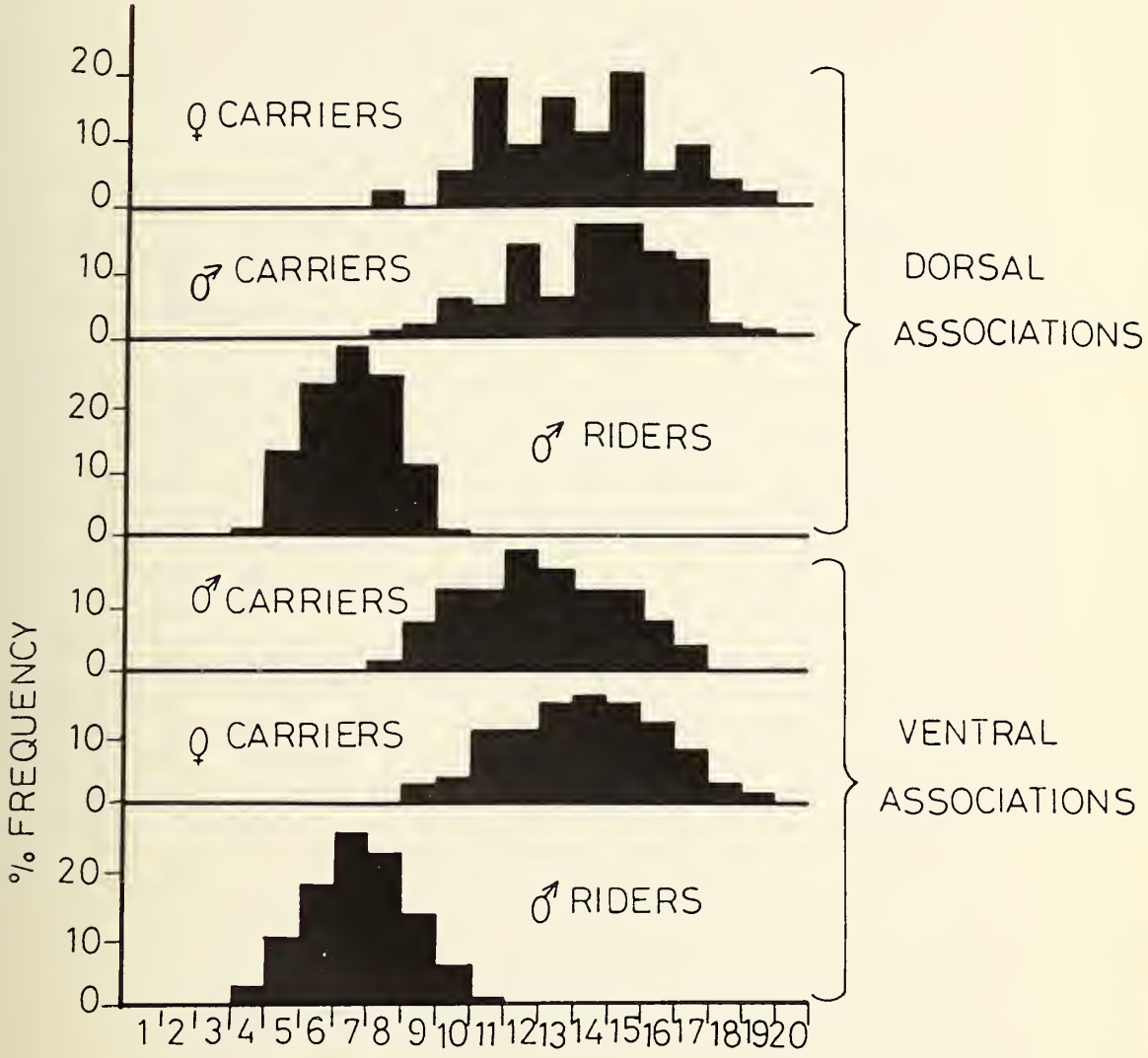

Figure 8. Size-frequency distributions of male riders and male and female carriers, in aboral (dorsal) and oral (ventral) associations, at Keppel in 1973.

iations in the corded-off area were counted from March through to June. The dives were twice weekly in April and May, and daily in June. On 17th May six dives were made between 06.45 hours and 18.15 hours. A peak of mating activity was observed at midday. On 23rd May eight dives were made between 05.00 hours and 20.00 hours. During these eight dives mating was found to be at a low level. Between 13th and 19th June three night-dives showed the same high intensity of mating as had been observed at midday on 17th May. There was therefore no indication that mating had any diurnal connection.

Figure 9 shows the number of associations in the area (maximum in any 24-hour period) plotted with the maximum daily state, maximum wind velocity, hours of daylight, daily 'light bottle' titrations, and sea temperature. It can be seen that in mid-May there was a rise in mating activity. This coincided with a period of stormy weather.

In June another spell of rough weather occurred, and high intensity mating began once more, tailing off in the succeeding two weeks. As in 1972, during the whole period of mating behaviour the brittlestars continued to feed, as indicated by reaction to carrion, and on one occasion the rider was actually being ingested by the female carrier during mating. It was during the second peak of mating activity that spawning began and continued in the brittlestar bed.

Figure 10 provides a more detailed analysis of this period. Calm weather continued until 10th June, 11th and 12th June were stormy, then calm weather returned on 13th June. (The waves produced by winds of less than force 4 have no effect on the brittlestar bed, and are taken as calm weather). The intensity of mating, as indicated by the number of associations in the area, was highest on 12th June, dropping abruptly to 14th June and then tailing off more gradually to 28th June, after which no more mating was observed. On 12th June none of the brittlestars had spawned. On 14th June 87% of a sample of 100 specimens had spawned. Between 17th and 23rd June some 90% of the samples were observed to have spawned. The remaining 10% had spawned by 28th June. The mean number of riders per carrier in oral associations was highest on 12th June, dropping by just under half on 14th June, and rising slightly on 17th June.

At the Red Buoy station (some 300 metres north of Keppel Pier) 76% of the population had spawned by 26th June.

Post-Spawning Observations

Weekly plankton samples were routinely examined for the presence of *O. nigra* plutei, but although this species is the

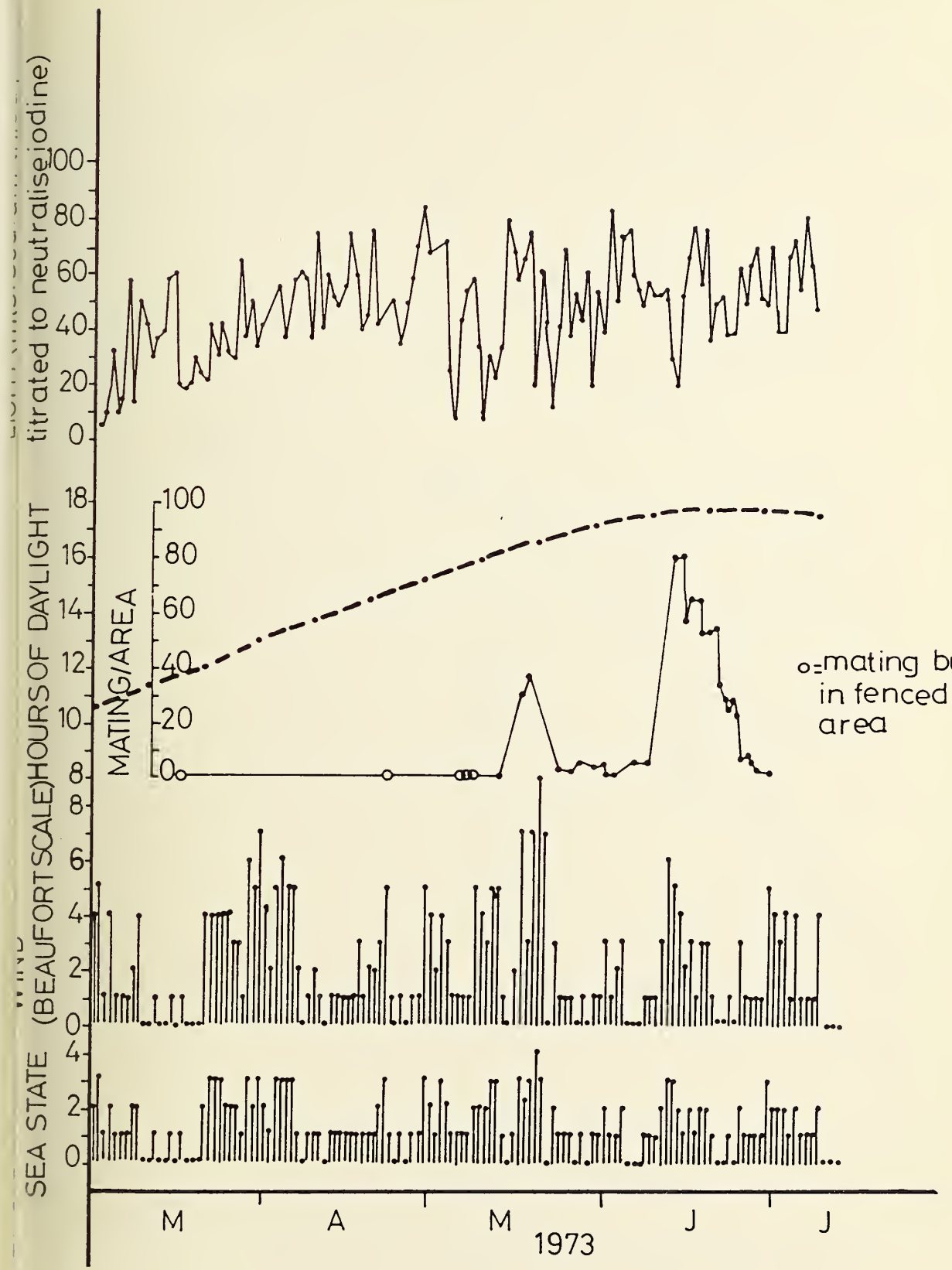

Figure 9. The intensity of mating, as expressed by numbers mating in the lined-off area, plotted with the weather conditions.

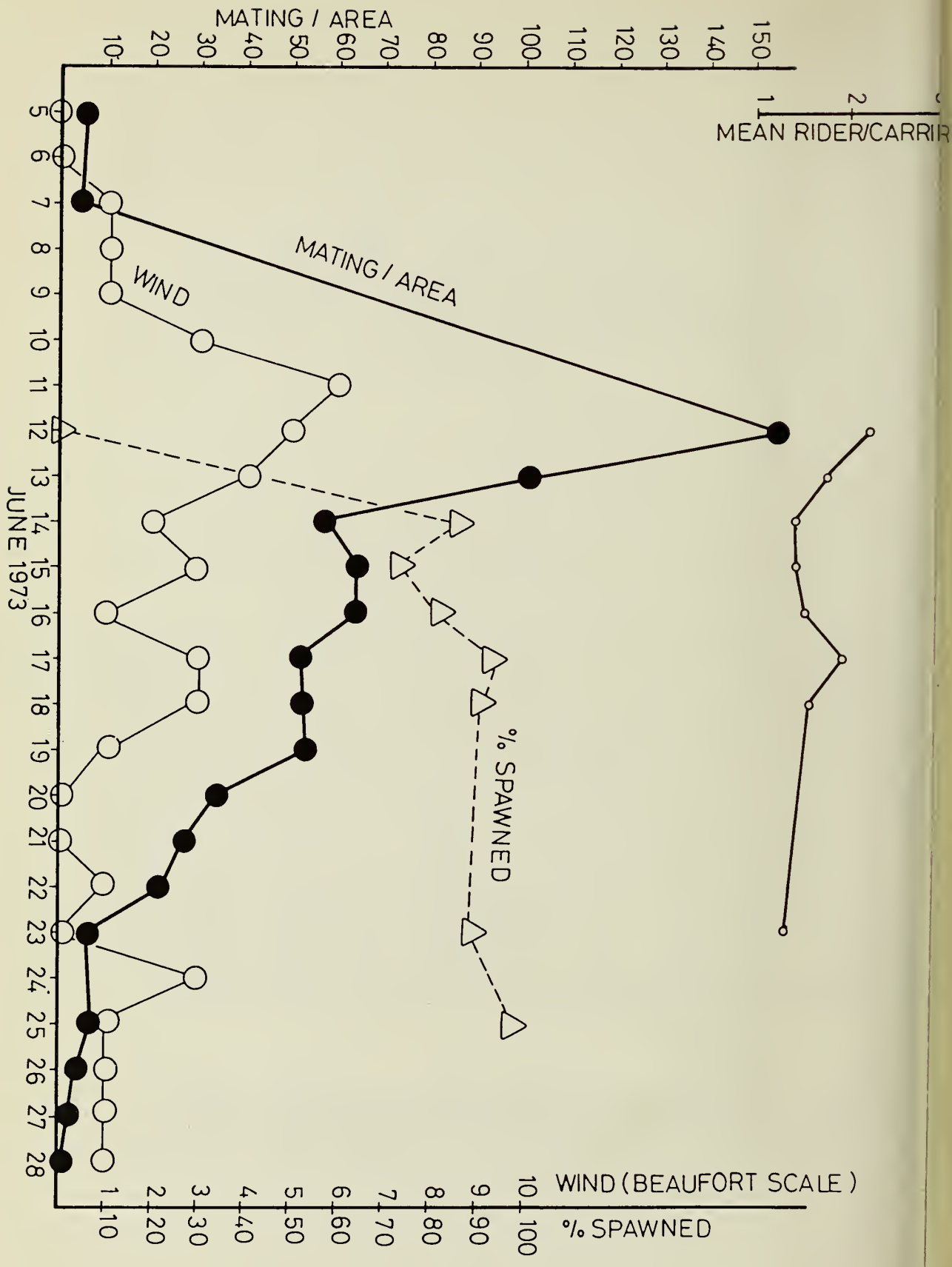

Figure 10. Detailed record of mating during June 1973.

commonest ophiuroid in the Clyde only occasional plutei were found during August and September in 1972 and 1973. Metamorphosing ophiuroids were found in plankton samples in January, February and June 1972 and in February 1973. Their disc diameters were between 0.46 mm and 0.63 mm. The arms had 5-6 joints each. It was found impossible to raise them in captivity. It is difficult to distinguish families before a disc diameter of 1.5 mm is reached, since they are convergent in form when small (A.M. Clark, personal communication, 1973).

Discussion

The currents flowing in the heavily-flagellated bursae of *Ophiocomina* have been described by Wintzell (1918), Gislen (1924) and Fontaine (1961). The writer found that the bursae communicated with tissue between the lobes of the gonads. The function of the bursae in ophiuroids is somewhat obscure, although a respiratory function has often been indicated.

Pentreath (1971), however, working with three species of New Zealand intertidal ophiuroids, failed to demonstrate a respiratory function. Holland and Holland (1969) have suggested that in the sea-urchin *Psammechinus microtuberculatus* (Blainville) nutritive phagocytes transfer nutrients to the germinal cells during gametogenesis. The role of nutritive phagocytes in the gonads of *Ophiocomina* have not been examined, but bearing in mind Pequignat's (1966) observations on coelomocytes in epidermal feeding it would seem worthwhile seeking a nutritive rather than a respiratory function for the bursae. The bursal currents may function to provide a constant flow of food particles to the spaces between the gonads, where these particles can be ingested by phagocytes, and hence transferred to the germinal cells. Fontaine (1961) observed detritus leaving the bursae by means of vibratile currents and entering the mouth. He ascribed this to a sanitation function, but does not state at what time of the year he made the observation.

Moore (1935) reported that in some areas male and female *Echinus esculentus* grow at different rates. Gonor (1973) found significantly more males than females in different intertidal populations of the echinoid *Strongylocentrotus purpuratus*. In the populations of *O. nigra* studied here, males and females were approximately the same size and the sex ratio equal. Since any population seems to be formed from essentially a single settlement (Gorzula, 1976) it is unlikely that males and females grow at a different rate.

Sexual behaviour occurred for a period of some two months before spawning, and consisted of small individuals riding on large ones. All riders were males. Hyman (1955) lists four in-

stances of ophiuroid species in which a dwarf male clings to the female. All these reports were from the southern hemisphere. The fact that the riders are all males at first suggests a direct sexual function of the associations, such as true copulation. However, since *Ophiocomina* does not brood its eggs, why should this species evolve a complex behaviour not found in other ophiuroid species, when simple spawning direct into the sea-water is seemingly adequate? The sexual composition of the carriers is rather difficult to interpret. In 1972 59% of the aboral carriers were female, and in 1973 the figure was 40%. In 1972 89% of the carriers in oral associations were female, and in 1973 65% were female. The male rider with a female carrier in an oral association have their bursae in close proximity, and this would undoubtedly ensure fertilisation. On the other hand male riders in aboral associations with female carriers, secondary riders, and riders on male carriers, are more abundant, and in these associations there is no proximity of male/female genital openings. Laboratory investigation suggested that there was an initial female attractant, but also an attractant from males. Hyman (1955) does not specify the ophiuroid species to which she refers, but states that males usually spawn first, followed later by other males and then by females. If this is widespread among ophiuroids, the mating behaviour of the small males may be an elaboration to provide more exact synchronicity. A working hypothesis could be that the small males act as primers for all the other brittlestars. This could set off a chain reaction at spawning time.

The intensity of mating showed a positive correlation with storms, and spawning occurred after the storm nearest to the summer solstice.

O. nigra exhibits specific behavioural response to storms in order to stabilise the beds (Gorzula, 1976). Because of this, the fact that mating behaviour is restricted to small males may be a compromise, since if all the males on the bed were mating, mechanical stability might be lost during a stormy period, and the resulting pairs washed off the beds. At Keppel 87% spawned within a two-day period, but it is suspected that the period may be considerably shorter. This presumably resulted in a vast number of larvae entering the plankton. Few larvae, however, were ever seen in the plankton. Fenaux (1972) noted that there were not many larvae of *Ophioderma longicauda* (Retzius) recovered from the plankton, and correlated this with the small number produced and the short pelagic life. The apparent absence of *Ophiocomina* larvae in plankton is probably explained by such a synchronicity of spawning that the larvae are concentrated in a discrete water mass, as a result of which the chance of sampling one of these 'blobs' of larvae is low.

It should be mentioned in passing that the sexual behaviour observed at the Keppel station occurred because the population was of the right size distribution. At the Red Buoy station the brittlestars were from an older settlement, and thus in general were larger. There was thus a shortage of small males, which resulted in low-intensity mating behaviour, although spawning occurred at about the same time as at Keppel. Presumably in beds which are composed of small individuals the picture would also be a difficult one, but no such bed was observed during this study when mating was going on. Therefore in order to obtain a complete picture this phenomenon should be examined in beds of brittlestars of different age structures.

On the evidence obtained a mechanism may be postulated by which *O. nigra* beds are produced. Mating behaviour by small males, which occurs in the spring, could stimulate and synchronise spawning. Two physical factors are involved: day length and rough weather. These factors would probably act upon neuro-secretory cells. Neuro-secretory ganglia have been described in *O. nigra* (Fontaine, 1962). A neuro-hormone has been isolated from the radial nerve of asteroids which acts as a shedding substance (Chaet, 1967). The net result of synchronisation by small males in *Ophiocomina* could be that the gametes are released into a small volume of water. Larval behaviour probably prevents unduly wide dispersion. Settlement is apparently almost invariably on virgin ground (Gorzula, 1976), and this may be the case either because larvae select a suitable (uncolonised) substrate, as has been described in the case of many marine larvae, e.g. *Notomastus* (Wilson, 1937), or because they are inhibited from settling in an established community. A mature sponge/anemone/ophiuroid community has been shown to inhibit settlement of a variety of larvae (Goodbody, 1961).

The productivity of *O. nigra* is low as regards the growth component, since the brittlestar is slow-growing (Gorzula, 1976). The component of energy-loss with predation is similarly low, as predation is largely confined to browsing on arm-tips (Gorzula, 1976). *Ophiocomina* spawns annually after reaching an age of 3 or 4 years until death at approximately the age of 12 or 14 years. Purely hypothetically it can be said that if *Ophiocomina* lives 12 years, one-twelfth of the beds need recolonisation annually to maintain equilibrium. The young echinoderm community consists of *O. nigra* in excess of 10,000/ square metre, which is in the order of 40 times the density of older beds. Therefore of the thousands of gametes produced by a brittlestar only one-twelfth of 40 x 2 (since two gametes produce one larva) - i.e. about 6 - need to survive in order to produce a bed of newly-settled ophiuroids. This is very much a rule-of-thumb calculation, but it serves to illustrate that there is undoubtedly a vast mortality of *O.*

nigra larvae while they are in the plankton. Gonor (1973) calculated that the gonadal production of an average population of *Strongylocentrotus purpuratus* on a rocky shore was 1 Kg dry weight of organic matter per square metre per year. Moore and Lopez (1966) estimated that a population of *Moira atropus* (Lamarck) living in an area comprising a tenth of one square mile annually produced a metric ton of dry organic matter, 30% of which was spawn. The energy-input of *Ophiocomina* via spawn into the Clyde sea area warrants attention directed to placing the ophiuroid beds in proper perspective.

Acknowledgements

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THE IMPORTANCE OF NON-VERTEBRATE AGENTS IN THE DECOMPOSITION OF SHEEP CARRION ON MOORLAND IN WEST SCOTLAND

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Introduction

Vertebrate scavengers are of major importance in the removal of sheep carrion from the hill, those which were largely responsible in a study area on the Drimnin estate being Foxes, Hooded Crows, and Ravens, with limited scavenging by Golden Eagle, Common Buzzard, and Great Black-backed Gull (Hewson and Hancox, unpublished data 1977-78). The less overt but complementary role of non-vertebrate agents contributed substantially to the decomposition of sheep carrion, and was investigated specifically during the 1978 sheep season, as delimited by the autumn sales.

The study area comprised the 2800 hectare Drimnin estate at the north-west tip of the Morvern peninsula, which rises to a height of 367 metres and is predominantly heather moorland, interspersed with areas of *Molinia - Trichophorum* grassland and bracken, with pockets of birch woodland along the coastal cliffs and valleys. The estate supports some 850 ewes, 100 cattle, and 250 Red Deer, although the latter also have access to a portion of a neighbouring property.

Methods

Sheep and deer carcases were located by systematic searching, autopsied, using Rowley's criteria (1970), for cause of death, identity of scavengers, and condition, and then kept under surveillance to determine the relative importance of the various scavengers involved and the rate of decomposition. Dissection and disturbance of carcases were kept to a minimum, so that it was not always possible to differentiate fully between putrefaction by bacteria and fungi and invertebrate scavenging, but non-vertebrate decomposition collectively was clearly distinguishable from 'breaking' by Fox or birds. Thus the main scavenger involved at each carcase was determined.

Collateral studies of lamb growth rates suggest that the weight of meat and viscera available to scavengers per carcase was on average 3 kg from April to June, 7 kg during July-August, and 15 kg during September-October, whilst adult sheep yielded some 20 kg, so that the biomass of carrion consumed by Foxes, birds and non-vertebrates could be estimated approximately.

Adult insects were collected from carcases for identification, and later visits often revealed the identities of larvae previously recorded, when newly emerged adult flies were found on old gutted carcases.

Decomposition of Vertebrate Carcases

The serial succession in the decomposition of vertebrate carcases has been variously divided into categories by different workers (Payne 1965), but there are four basic stages:

1. Fresh.

2. Rapid Decomposition, usually comprising a Bloat Phase due to the accumulation of gases generated by the gut flora, succeeded by a Deflation and Leakage Phase resulting in a putrefaction puddle beneath the carcase.

3. Dry Remains, the eviscerated carcase remaining virtually intact and *in situ*.

4. Scattering, of bones and wool, usually by vertebrate scavengers or by wind or water. The final disintegration of bones, wool, and hooves, buried amongst vegetation, was ultimately due to slow microbial decay.

The rate and sequence of events in the main Rapid Decomposition phase was determined by two principal factors:

a. The spatio-temporal availability of carcases to vertebrates in relation to other, often preferred, sources of food.

b. The availability of carcases to insect scavengers, in conjunction with the physicochemical micro-environment. Insects were of subsidiary importance to vertebrates, owing partly to the delays inherent in oviposition and larval growth, and partly to the seasonality of emergence and the few species present.

The Pattern of Non-Vertebrate Scavenging

Study of non-vertebrate scavenging was restricted to those carcases ignored or undiscovered by predators. Out of sixty sheep and ninety-one lamb carcases examined during the 1977-78 season, only three May lambs were recovered for autopsy before some vertebrate scavenging had taken place, and the majority of mainly Fox or bird scavenged carcases were gutted in 2-4 weeks before appreciable mobilisation of insect scavangers had occurred. Some lamb carcases were gutted by flocks of Ravens within 1-4 days of death.

The bulk of non-vertebrate scavenging occurred during the peak period of availability of both sheep and deer carrion, i.e.

from February to early June (see Table 1), and included at least twelve ewes from which birds removed little apart from the unborn lamb.

Decomposition of these carcases was correspondingly slow, taking from 1-2 months or more, in marked contrast to the rapidity of vertebrate scavenging during the two adjoining periods of food shortage (a) during the winter, and (b) in July-August when few sheep or lambs die, and when voles are better concealed from predators by tall cover. Peri-natal carrion mutton was clearly not a preferred food of predators, since non-vertebrate scavenging accounted for nearly 52% of all adult sheep carcases (Table 1), whereas the less than 3% of all lamb carcases accounted for by non-vertebrates were ones apparently not discovered initially by Foxes or corvids.

Adult sheep carcases which were particularly avoided by predators included twelve which died near crags, buildings or human disturbance, and nine which may have been unwholesome fare, death involving louping-ill virus or septicaemia, while a further dozen died partially submerged in bogs or streams. Such 'sheep islands' were scavenged by predators dorsally, or even hauled out from bogs by Foxes during periods of food shortage, but in the main decomposition was due to microbial putrefaction, the process taking three months or longer owing to the low temperature and partially anaerobic conditions, unless insects gained access to the carcase.

Carrion flies and beetles occurred at virtually all carcases during the warmer months of the year, from April to October, and were responsible for the bulk of non-vertebrate carrion removal: in particular, maggots gutted several summer lamb carcases, which were lying amongst tall vegetation and so undisturbed by predators, in less than two weeks, a maximal rate of decomposition similar to that found for baby pig by Payne (1965).

Although few carcases remained undiscovered by predators, in the decomposition of sheep carrion non-vertebrate agents (633 kg) were almost as significant as birds (837 kg), and nearly four times as important as Foxes (168 kg) (see Table 1).

The Insect Succession

The insect succession was almost invariably complicated by vertebrate 'breaking'. This could either accelerate the process, initially by providing additional access sites for the liquid feeding and oviposition of flesh and flow flies to the usual moist thin-skinned areas (eyes, nostrils, mouth, anus and vulva), and in the later stages of decomposition

Table 1 Agencies mainly responsible for scavenging sheep carcases.

Month	Fox		Bird		Non-vertebrate		Estimated weight (kg) scavenged by:		
1977-78	Sheep	Lamb	Sheep	Lamb	Sheep	Lamb	Fox	Bird	Non-vertebrate
Nov.			4					80	
Dec.			3					60	
Jan.			1					20	
Feb.	1		1		4		20	20	80
Mar.	2		4		3		40	80	60
Apr.	1	3	4	8	13		29	104	260
May		13	5	38	7	2	39	224	146
Jun.		1		6	3		3	18	60
Jul.			2		1			40	20
Aug.		1		3		1	7	21	7
Sep.				6				90	
Oct.		2	1	4			30	80	
Total:	4	20	25	65	31	3	168	837	633

by facilitating penetration into cranial cavities and long bone marrow; or vertebrate breaking could inhibit the decomposition of carcases by enhancing dessication, and by the consumption of fly maggots and adult Silphid beetles by both corvids and Foxes. A cyclic renewal of insect scavenging often resulted when protracted rain or a gradual disappearance amongst growing vegetation had restored the availability of dessicated carcases to, or permitted re-colonisation by, carrion insects.

The rate of decomposition and pattern of the insect succession was largely determined by the relative humidity of the carcase micro-environment, the most important insect scavengers being large blow fly maggots which were very dependent for feeding on a supply of moist 'meat broth'. Atmospheric temperature was of only secondary importance, owing to the generation of metabolic heat. Warm dry conditions optimal for insect activity, however, were most conducive to the initial olfactory location by flies and the subsequent brisk invasion by rapidly growing maggots within days of death of fresh carcases. Some 90% of the major carrion-consuming maggots belonged to bluebottles *Calliphora* spp., but greenbottles *Lucilia* spp. occurred later in the summer and some other large Muscid allies such as *Sarcophaga* sp. were also present.

Burying or sexton beetles belonging to the family Silphidae, the other main group of insect scavengers, were less dependent on a high relative humidity than were flies, since their larvae, which again were the main consumers of carrion, possess chewing mouthparts. Adults were attracted to carcases by the increasing 'gamey' odours or by male pheromones (Linssen 1959), tending to arrive later than flies during the final stages of Rapid Decomposition or the Dry Remains phase. Some 59% of the Silphids belonged to the species *Thanatophilus rugosus* L. which was commonest during April-May, while other species which occurred particularly from May to August included *Necrodes littoralis* L. (26%), *Oceoptoma thoracicum* L. (11%), with a few cases of orange-banded *Necrophorus* spp. (eg. *N. vespilloides* Hb.). "Carrion beetle" may be a partial misnomer when applied to Silphids, since *T. rugosus*, *N. littoralis*, and *Necrophorus* spp. are all known to prey on dipterous larvae, while other necrophilous beetles recorded at Drimnin may be essentially predators, including *Hister* spp. and larger Staphylinids such as *Creophilus maxillosus* L. (Linssen 1959, Payne 1965).

Other insects present, which may have accounted for a small amount of meat removal, included such late phase scavenging beetles as Nitidulids, although at Drimnin no Dermestids or Trogids were seen, the latter being rare in Scotland; there were also odd occurrences of ground beetles (*Feronia* sp.), and

wasps *Vespula* sp. Probably all the other invertebrates recorded were unimportant as consumers of carrion. These included: many of the smaller flies (eg. *Scopeuma* sp.) mainly attracted to the dung and rumen content of carcases; essentially dung-feeding beetles comprising Hydrophilids (*Cercyon* and *Sphaeridium* sp.), Scarabaeids (*Aphodius* and *Geotrupes* spp.), and Silphids (*Catops* sp.); earthworms, slugs, millipedes, spiders, and ants, all of which were occasionally found within or beneath carcase shelters.

Conclusion

Blow-fly maggots were shown to be the major factor in the initial decomposition of the majority of sheep carcases ignored by predators, while microbial decay was the ultimate factor in the decomposition of persistent skeletal and keratinised elements; non-vertebrate agents were therefore vital to the overall re-cycling of sheep carrion within the moorland ecosystem.

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AUTUMN WADERS IN THE OUTER HEBRIDES

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Introduction

Little quantitative work has been published on the waders of the Outer Hebrides, and since these isles contain very small estuaries they were not surveyed during the BTO/RSPB/WT Estuaries Enquiry in the early 1970s. Statements by Baxter and Rintoul (1953), however, that "large autumn flocks of Sanderlings" and "immense flocks of Ringed Plovers" occur there, suggest that the islands support sizeable numbers of waders. Baxter and Rintoul also record that Dunlins, Redshanks, Bar-tailed Godwits, and Turnstones are common passage migrants. Apart from such statements little has apparently been published on the wader populations of these islands. We therefore travelled to the Uists and Benbecula (the central islands of the group) on 26th August 1973 to carry out one week of census work, and also to trap waders in an attempt to determine the origins of the birds found there in autumn.

Two major coastal wader habitats can be recognised in these islands; rocky shores and sandy beaches, both facing the open sea, and large flats (strands) composed of fine sand. The latter have formed in sheltered inlets or between islands, and there are five such areas in the islands visited: Vallaquie Strand/ Traigh Ear; Vallay Strand; Loch Paible; Oiter Mhor and the strand between North Uist, Baleshare and Benbecula; and between Benbecula and South Uist (Figure 1). The sand flats are rich in invertebrate life and the following animals were recorded: *Arenicola* (lugworm), *Nephtys*, *Hydrobia*, *Cardium* (cockle), *Macoma* and *Crangon* (shrimp).

Census Work

The birds on the strands were censused either by scanning the flats at low tide or, more usually, by walking round the margins at high tide and locating high tide roosts formed by the birds which fed on the flats (Table 1). Roosts were found on the sand bar at the north-west corner of Vallaquie Strand (Bar-tailed Godwits, Ringed Plovers and Sanderlings), salt-marshes at the northern part of Baleshare (Dunlins and Ringed Plovers), islands near Carinish (Curlews), and islands at Gualann (Oystercatchers,

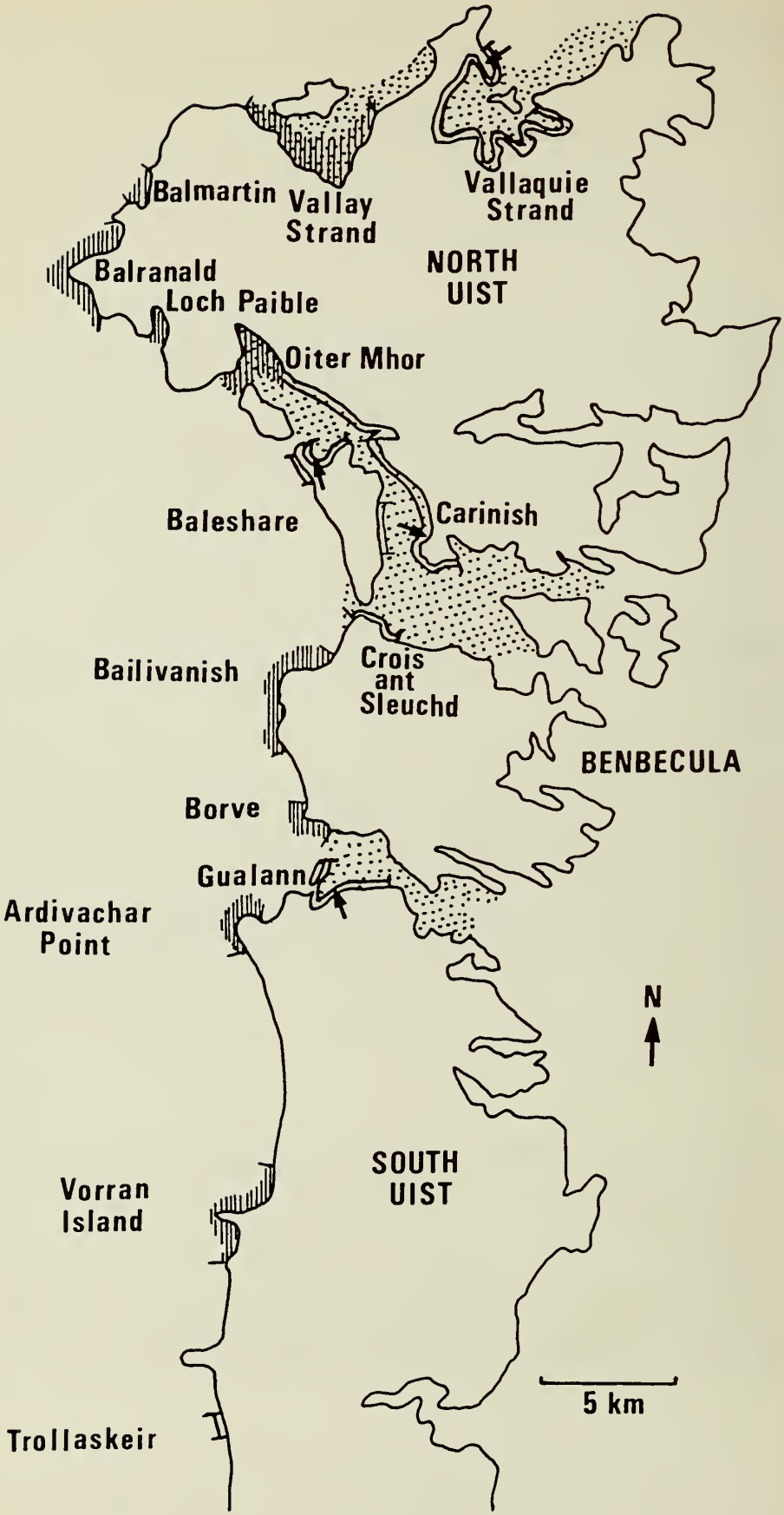

Figure 1. The Uists and Benbecula showing the regions where waders were counted. Hatched areas - censused at low tide. Double lines - censused at high tide. Stippled areas - sand flats. Arrows indicate high tide roosts.

Redshanks, Bar-tailed Godwits, and Ringed Plovers) (Figure 1).

The waders on the 28km of rocky shore and sandy beach which face the Atlantic were also censused (Table 1), counts usually being carried out at low tide. At this time of year the beaches were strewn with torn seaweed and large numbers of Turnstones were foraging around these piles of weed. Other species also had their preferred feeding microhabitats on the beaches; Bar-tailed Godwits fed mainly whilst wading, Sanderlings followed the waves up and down the beach, Ringed plovers were found on well drained sand, and Dunlins on wet patches. Turnstones were also plentiful on the rocky shores, but Purple Sandpipers were noticeably absent.

The data (Table 1) support Baxter and Rintoul's (1953) statements that large numbers of Ringed Plovers and Sanderlings occur in the Hebrides. When compared with the peak 1972/73 and 1973/74 Scottish estuarine totals of 1593 and 4421 for Ringed Plovers and 151 and 501 for Sanderlings respectively (Prater, 1973 and 1974) it is apparent that the islands of the Outer Hebrides are an important area for these species.

Biometric and Moult Studies

Birds netted for ringing were weighed to the nearest gm and their bills and wings measured to the nearest mm. Wing lengths refer to maximum chord (Evans, 1964).

Although only small numbers were caught, some tentative conclusions can be made as to the origins of the Ringed Plovers. They appeared to be British breeders since they had the long wings characteristic of this population (Table 2). Summers (1974) gives a value of 138.1 ± 2.7 mm (mean ± S.D.) for 21 birds breeding in eastern Scotland, which agrees closely with the measurements for Hebridean adults. Other populations have shorter wings (Prater *et al.*, 1977). Further evidence suggesting that the Hebridean Ringed Plovers were of the British population comes from the fact that the adults were in the later stages of wing moult, having on average only 1.3 (0-3) old primaries to shed. Minton (1972) has stated that only the British population moults the complete wing in this country, from July to September, whilst migrant populations from the arctic do not. It is likely that the birds we captured were local breeders, since some 780-950 pairs of Ringed Plovers breed in the Uists and Benbecula (Fuller, 1978).

Both Sanderlings and Turnstones were in wing moult, showing that continued migration was not imminent and that it was likely they would remain to winter. Both species were in earlier stages of moult than the Ringed Plovers, the Sanderlings having on

Table 1	Oystercatcher	Ringed Plover	Golden Plover	Grey Plover	Knot
SAND FLATS					
Vallaquie Strand	73	201	200	-	4
Vallay Strand	58	44	-	-	-
Loch Paible	2	16	20	-	-
Oiter Mhor	21	40	-	-	8
Carinish	1	-	-	-	-
Baleshare	33	180	128	-	10
Crois ant Sleuchd	3	33	-	-	-
Gualann	400	100	-	5	3
ROCKY SHORES & BEACHES					
Balmartin	8	-	-	-	-
Balranald	97	115	-	-	-
Bailivanish	21	242	-	-	3
Borve	27	81	-	-	-
Ardivachar Point	29	120	-	-	-
Vorran Island	107	343	-	-	9
Trollaskeir	68	1	-	-	8
Total	948	1516	348	5	45

Table 1. The numbers of waders recorded at different sites in the Outer Hebrides from 28th August to 2nd September 1973.

Sanderling	Dunlin	Bar-tailed Godwit	Whimbrel	Curlew	Spotted Redshank	Redshank	Greenshank	Common Sandpiper	Turnstone	Total
200	50	301	1	44	-	32	10	-	3	1119
-	5	(123)	-	19	-	76	3	-	-	328
-	1	-	-	38	-	-	-	-	1	78
-	9	142	-	15	-	54	3	-	4	296
-	-	6	-	74	-	25	-	-	1	107
2.	137	1	-	19	-	29	-	-	1	540
1	-	1	-	1	-	-	-	-	-	39
1	10	160	-	22	-	120	-	-	-	821
-	-	-	-	-	-	16	-	-	7	31
23	1	1	1	25	-	55	1	-	327	646
81	60	-	-	8	1	58	-	-	457	931
8	1	14	-	38	-	30	-	-	28	227
62	72	(80)	-	2	-	100	-	1	115	581
18	37	8	-	27	-	54	-	-	85	688
3	-	-	-	-	-	43	-	-	27	150
399	383	634	2	332	1	692	17	1	1056	6379

Brackets round the numbers of Bar-tailed Godwits indicate that they were counted at that site at low tide but believed to be included in high tide counts at other sites; these bracketted numbers are omitted from the total.

Table 2. Measurements of waders caught in the Uists on 29th August and 3rd September 1973

Species	Age	No.	Wing Length (mm)		Bill Length (mm)		Weight (gm)	
			Range	Mean	Range	Mean	Range	Mean
RINGED PLOVER	Adult	11	134-142	137.8	14.5-16	15.3	63-74	65.5
	Juvenile	3	130-142	136.0	14-15	14.5	57-70	63.3
KNOT	Juvenile	1	-	160	-	27	-	80
SANDERLING	Adult	3	121-127	123.7	22-25	23.7	45-48	47.3
	Juvenile	1	-	124	-	25	-	53
TURNSTONE	Adult	6	152-159	155.2	22-24	23.2	97-113	108.7
	Juvenile	2	151-157	154.0	21-23	22.0	90-92	91.0

average 4.7 (3-6) old primaries to shed and Turnstones 2.8 (0-4).

The only indication of a new arrival was a juvenile Knot which, although apparently in good health, weighed only 80 gm. The mean winter weight for these birds on the Tay is 135.8 gm (Tay Ringing Group, unpublished data). Only 45 Knots were seen but Dr. L.H. Campbell (pers. comm.), who visited the islands from 16th to 18th September 1973, saw 100 at Garry a siar (Benbecula).

Age Ratios

It was possible to observe many of the birds at close quarters and to identify juvenile birds, based on criteria outlined by Minton (1972) (Table 3). In early autumn, when juveniles are in fresh plumage and adults are still in breeding plumage, the distinctions are quite obvious. Practically all the Dunlins and Knots were juveniles, whilst a lower percentage of juveniles occurred in the Ringed Plover and Turnstone populations. Presumably adult Dunlins and Knots migrate at different times or by different routes.

Table 3. The percentage of juveniles in samples of observed birds.

	Number Aged	Percentage Juvenile
Ringed Plover	32	66%
Knot	13	100%
Dunlin	165	97%
Turnstone	47	19%

Summary

The sand flats, rocky shores and beaches of the Uists and Benbecula support quite large wader populations in autumn, 6379 being counted in selected regions. Totals of 1516 Ringed Plovers and 399 Sanderlings counted indicate that the Hebrides are an important area for these species. Wing measurements and observations of moult suggested that the Ringed Plovers were local breeders. Information on age ratios was obtained for four species.

Scientific Names of Species Mentioned in the Text

Oystercatcher *Haematopus ostralegus*
Ringed Plover *Charadrius hiaticula*
Golden Plover *Pluvialis apricaria*
Grey Plover *P. squatarola*
Knot *Calidris canutus*
Sanderling *C. alba*
Purple Sandpiper *C. maritima*
Dunlin *C. alpina*
Bar-tailed Godwit *Limosa lapponica*
Whimbrel *Numenius phaeopus*
Curlew *N. arquata*
Spotted Redshank *Tringa erythropus*
Redshank *T. totanus*
Greenshank *T. nebularia*
Common Sandpiper *Actitis hypoleucos*
Turnstone *Arenaria interpres*

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